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CONTENTS

	Page
Colonial Research Service	329
Advances in Enzymology. By Prof. J. H. Quastel, F.R.S.	331
Genetical Theories. By Prof. C. H. Waddington, F.R.S.	333
Science and the Seventeenth Century. By Col. H. D. Anthony	333
Peasant Work and Worship in the Deccan. By Dr. J. P. Mills, C.S.I., C.I.E.	334
State-aided Research in France and French Scientific Instruments. By Frank Greenaway	336
Yukon–Alaska Expedition of the Arctic Institute of North America. By Prof. N. E. Odell	337
The Sutton Hoo Ship-Burial. By R. L. S. Bruce-Mitford	339
News and Views	341
Isolation of a Crystalline Toxic Factor from Agenized Wheat Flour. By Dr. P. N. Campbell, Dr. T. S. Work and Sir Edward Mellanby, G.B.E., K.C.B., F.R.S.	345
Direct Optical Measurement of the Length of Organic Molecules. By Dr. J. S. Courtney-Pratt	346
Changes in Fibre-length within One Growth Ring of Certain Angiosperms. By I. J. W. Bisset, Dr. H. E. Dadswell and G. L. Amos	348
National Research Council of Canada: Annual Report	349
Residential Courses for Supervisors. By T. H. Hawkins	350
M.K.S. System of Electrical Units. By Prof. James Greig	351
Energy of the Stars	351
Astronomy and Navigation	352
Letters to the Editors:	
Cosmic Rays and the Magnetic Field of the Sun.—D. W. N. Dolbear and H. Elliot	353
Distribution of Radiation from the Undisturbed Sun at a Wavelength of 60 cm.—H. M. Stanier	354
Heavy Fragment Disintegrations.—P. E. Hodgson	355
Radioactivity of Potassium.—Dr. F. W. Spiers	356
Structure of β-Tungsten Oxide.—Arne Magnéli	356
A Radioactive Method for Measuring the Adsorption of Dissolved Substances on Liquid Surfaces.—Gunnar Aniansson and Prof. Ole Lamm	357
Light Output from a Spark 'Point Source'.—W. G. Standring and J. S. T. Looms	358
Dielectric Behaviour of Methyl Palmitate in the Microwave Region.—H. F. Cook and T. J. Buchanan	358
Birefringence in Rubbers.—D. W. Saunders	360
Elastico-Plastic Straining when the Principal Stresses Rotate.—Dr. K. H. Swainger	360
Relativistic Interactions Between Two Nucleons.—C. Marty	361
Meyer Analysis of Metals.—Prof. Hugh O'Neill	362
The Geminid Meteor Shower.—Miroslav Plavec	362
Ratio of Total to Selective Absorption.—Dr. E. M. Lindsay	363
Effect of E-Avitaminosis on the Histiotrophic Nutrition of the Mouse Embryo.—Prof. Paavo Suomalainen	364
Sinus Gland and Tyrosinase Activity in *Carcinus maenas*.—G. Krishnan	364
Enzymic Decomposition of Nitromethane by Liver Homogenates.—Fujio Egami and Ryo Sato	365
Enzymic Inactivation of Serum Gonadotrophin.—Prof. C. Rimington and Dr. I. W. Rowlands	366
Amino-acids in Soil.—J. M. Bremner	367
Occurrence of Pterin Pigments in Hymenoptera.—Jean Leclercq	367
Quadruple Structure of the Centromere.—Joe Hin Tjio and Albert Levan	368
Colour-Contrast Phase Microscopy.—Frederick C. Grigg	368
Preparation of Acetobrome Sugars.—M. Bárczai-Martos and F. Korösy	369
Difference Equations of Moment-Generating Functions for some Probability Distributions.—Prof. P. V. Krishna Iyer	370
Sulphanilamide as a Preservative for Sweet Juices from Palm Trees.—D. G. Walawalkar	370
Rapid Estimation of Standard Deviation.—A. Marriage	370

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COLONIAL RESEARCH SERVICE

IN a speech in the House of Lords on November 30, Lord Tweedsmuir referred to the deterrent effect of political uncertainty and of misrepresentation on recruitment for the British Colonial Service. One factor in that situation has been the biased and unfriendly criticism in the Trusteeship Council and even at the General Assembly of the United Nations. Now we have the report of the visiting mission of the United Nations Trusteeship Council on the Cameroons under British administration giving a very different picture. The mission consisted of an Iraqi, a Belgian, a Mexican and an American, and it pays high tribute to the excellence of the aims of British Colonial administration and to the way in which those aims are being implemented. This report appeared very shortly after the appearance of the Colonial Office pamphlet, "Appointments in His Majesty's Colonial Service"[1], and the announcement on January 30 by Mr. D. R. Rees-Williams, Under-Secretary for the Colonies, of the formation of a Colonial Research Service, to take effect from January 1, 1949. All these factors should help to re-establish that professional esteem which must always be one of the intangible forces determining entry on such a career.

The new edition of "Appointments in His Majesty's Colonial Service" is indeed well designed for its purpose. It describes the standard of academic, professional or technical qualifications required for the wide variety of posts now available and gives just a hint of the imagination and common sense of a high order, the deep spirit of service and the wide humanity which are also needed if the great traditions of the past are to be upheld and the Colonial Service of to-day and to-morrow is to discharge the new tasks and responsibilities of the stage of partnership which is succeeding that of trusteeship. The transfer of more and more responsibility to the people of the Colonies themselves, and the giving of advice effectively, make even bigger demands on the Colonial officer; and to discharge such duties he needs not only the high ideals to which Mr. Creech Jones, the Secretary of State, refers in his foreword, but also in some measure at least the support and approval of informed world opinion.

Appreciations such as that contained in the report of the visiting mission to the Cameroons can therefore play an important part in supplementing the factual appeal of the Colonial Office pamphlet. This gives not only some account of the general conditions of service and salary-range and a summary of the various appointments dealt with by the Director of Recruitment (Colonial Service), the Overseas Nursing Association and the Crown Agents for the Colonies, but also a list of sources of information for certain appointments not within the Colonial Service and a short list of recommended books and papers. There is also appended a table showing the scale of recruitment during 1939–1948.

From the point of view of man-power, this is one of the features of the pamphlet of most general interest; and it is all the more so because the

information contained in the pamphlet as to the size of the individual services is rather sketchy. While, for example, it is indicated that there are in the administrative service some 2,000 permanent appointments, in the agricultural service 550, in the medical service 800, in the forest service 200, in the prisons service 150, in the survey service 210, and in the audit service 140, for the chemical service, biological appointments, civil aviation service, customs service, education service, engineering service, fisheries appointments, geological survey service, mines service, veterinary service, and others no figures are given. We are told that labour appointments number 200 and meteorological appointments 40; but for the rest it is impossible to form any opinion of the size of the Service or of the proportion of any individual section to the whole.

What would have been welcome in this pamphlet is an indication of the proportion which scientific and technical persons now bear to the whole Service, and the extent of the demand which the annual intake now makes upon the trained man-power—and woman-power—of Great Britain. The scale appended to the pamphlet shows, indeed, that in 1947 and 1948, when in all 1,169 and 1,163 appointments, respectively, were made by the Secretary of State, appointments, presumably essentially scientific, accounted for 467 and 564, respectively. These figures take no account of broadcasting, commerce and industry, customs, economics, education and the like appointments, although some technical if not scientific appointments may fall in these groups. In 1946 the corresponding figure was 668 out of 1,695, as against 114 out of 270 in 1939.

While these figures may well include some appointments which are neither scientific nor technical, it seems probable that something of the order of forty per cent of the appointments to the Colonial Service are now to scientific or technical posts, and that the proportion has not greatly changed from before the War, although the number of appointments has increased four-fold. The increased proportion of scientific workers and technicians in the Colonial Service relative to the administrator goes back to an earlier period, and the important feature at the present time seems to be the increasing demand which the Colonial Service as a whole is making on the output of trained man-power and woman-power. That demand may be eased to some extent by technical co-operation with the United States as contemplated apparently by President Truman under the Fourth Point; but for any considerable decrease in the demand we will have to await the full flowering of the Colonial universities.

In the meantime, the vast field of inquiry open in the Colonial Empire for scientific discovery and research may well increase the demand for men for scientific research in those under-developed territories. The African Regional Scientific Conference last year testified to the immense opportunities in this respect in Africa south of the Sahara, above all for investigations on the spot. In the Press conference on January 30 at which the formation of a Colonial Research Service was announced, Mr. J. C. Hibbert, the head of the Research Department, stressed the great openings and scope which the new Service offers to young people. While the Colonial Office has taken the fullest advantage of the assistance of such bodies as the Department of Scientific and Industrial Research, the Medical Research Council and the Agricultural Research Council, much research has to be carried out on the spot. In the past two years ten major and about fifty subsidiary research appointments were made; but another four hundred will probably be made during the development of the Service. The Service will not include officers who are appointed specifically to posts in the United Kingdom: such officers will be considered temporary or permanent members of the United Kingdom Scientific Civil Service.

Mr. Rees-Williams said that the object is to create a service with salary scales, terms of service and standards comparable with those enjoyed by research workers in Great Britain and which would offer the research worker the possibility of a continuous pension whether the whole or only a part of his career is spent in the Colonial Empire. The new scheme is designed to link together the scattered research workers in the Colonies and is intended to meet the needs, not only of those who propose to carry out their life's work in the Colonial territories, but also the home research worker going overseas for a few years, and the Colonial research worker who wishes to work in Britain for a few years. The Service was evolved by the Colonial Office in collaboration with scientific men at home and abroad and after consultation with the Colonial Governments. The terms and conditions of service are set out in a pamphlet entitled "Appointments in His Majesty's Colonial Research Service"[1], obtainable from the Colonial Office, which also includes details of recruitment arrangements in Canada, Australia, New Zealand, South Africa and Southern Rhodesia, and of the Colonial Research Fellowships to be granted during 1949–53. Candidates will be selected by competition based on personal interview and record, taking full account of academic attainments, health, character, personal fitness, and (where applicable) professional qualifications and civil employment. Superannuation will be provided under a contributory Colonial superannuation scheme to be introduced later this year, and the scheme will provide for some interchange between the Colonies, and for the establishment of regional organisations rather than small research institutes in every Colony. Stress was laid at the Press conference on the need for soil scientists, entomologists and fishery research workers, Dr. C. F. Hickling, fisheries adviser to the Colonial Office, emphasizing the world-wide shortage of the latter and the great scope for fish farming.

While no more than a rough estimate can as yet be formed of the extent to which the Colonial Research Service will affect British resources of scientific manpower, it is clear from this first statement that the scheme is designed imaginatively and will meet some of the real problems of the overseas research worker. Its provision for superannuation and for interchange should go far, by encouraging mobility and sabbatical leave, to break down the isolation which has been

such a handicap to the Colonial scientific worker in the past. If it should prove, furthermore, that the report of the visiting mission to the Cameroons betokens a wider appreciation of the work of the whole Colonial Service, there is every reason to hope that, with the new conditions of service, the Colonial Office will no longer find itself unable to obtain sufficient recruits of the high quality desired for its Research Service or for any other branch.

[1] Colonial Office. Appointments in His Majesty's Colonial Service. Pp. 111. (London: H.M. Stationery Office, 1950.) 1s. net.

[2] Colonial Office. Appointments in His Majesty's Colonial Research Service. Pp. 15. (London: Colonial Office, 1950.)

ADVANCES IN ENZYMOLOGY

Advances in Enzymology and Related Subjects of Biochemistry

Edited by F. F. Nord. Vol. 8. Pp. xi+538. 48s. Vol. 9. Pp. x+760. 54s. (New York and London: Interscience Publishers, Inc., 1948 and 1949.)

THESE two volumes contain twenty-two articles on a variety of subjects of enzymological and biochemical interest. They vary from a study of the function of cytoplasm to a discussion on industrial biosynthesis. They consist of authoritative essays, some of them extensive monographs, in special fields of biochemistry, and they well uphold the high standard set in previous volumes of "Advances in Enzymology".

Dr. Ludwik Monné gives a critical review of recent literature dealing with the structure of protoplasm, and he attempts to portray a consistent picture of the functioning of cytoplasm. He describes investigations on chromidia and shows how new work has demonstrated that ribonucleic acid is present within the cytoplasm (in the chromidia) and that thymonucleic acid is in the chromosomes. Chromidia and mitochondria differ from each other, the latter lacking ribonucleic acid. Nucleic acids appear to be concerned with mechanisms of protein synthesis, and it is claimed that "self-perpetuating corpuscles must be nucleoproteins". The chromidia are an organised system of chemical compounds and are self-perpetuating bodies similar to chromatin. Dr. Monné proceeds to compare various living fibrils and discusses plasma membranes, mitochondria, Golgi bodies, chloroplasts and cell organisation. An interesting and stimulating discussion of the metabolic activities of the cell follows, with comments on contractility, mobility, irritability, conductivity and permeability.

Drs. M. A. Lauffer, W. C. Price and A. W. Petre write on the nature of viruses, dealing with the plant and bacterial varieties. Virus mutations are discussed, and it is pointed out that studies on inheritance in viruses have shown that these entities are more highly organised than genes. They contain, in fact, a number of genes or gene-like structures. Great progress has been made in the last decade on the elucidation of the nature of viruses, the impulse being given by the crystallization and characterization of tobacco mosaic virus. Later work showing that this is a nucleoprotein has resulted in the application of the new techniques to purification of many other viruses. Details are given of their physical constants, and shadow electron micrographs of virus particles are included. All the plant viruses, as well as some of the animal viruses, seem to consist of nucleoproteins; others, like vaccinia virus, also contain fat and carbohydrate. Tobacco mosaic virus consists of sixteen to eighteen amino-acids, the number depending upon the strain.

A most informative article on the chemistry and enzymology of nucleic acids is contributed by Dr. F. Schlenk. This is particularly useful in view of the paucity of comprehensive reviews and monographs on the subject. The compounds discussed are classified into two main groups: one comprising ribo- and desoxyribo-nucleic acids and their split products; and the other comprising co-enzyme nucleotides such as adenine, riboflavin and nicotinamide nucleotides. The nucleotides are defined as the phosphoric acid esters of the nucleosides. The latter are the N-glycosides of naturally occurring bases, the carbohydrate being *d*-ribose, *d*-2-desoxyribose or some closely related sugar. The nucleic acids or polynucleotides are not yet clearly defined, and it is preferable at present to use the non-committal terms of ribonucleic acid and desoxyribonucleic acid, these being understood as collective terms, since evidence is appearing that each type is collective in nature. Dr. Schlenk discusses aspects of the metabolism of the constituents of nucleic acids, and describes recent spectrophotometric studies of these substances, pointing out the value of the application of spectrophotometry to enzyme and cytoplasmic studies. The enzymes hydrolysing the nucleosides, nucleotides and nucleic acids receive considerable attention, and a most interesting discussion is given of the architecture of the nucleic acids. It is emphasized that a new development in the nucleic acid field is the tendency to question the existence of distinct tetranucleotides as structural units of nucleic acids. In spite, however, of the increased interest in the chemistry and enzymology of nucleic acid, research activity in this field needs intensification. It is possible that this may take place now that well-defined substrates (nucleosides, nucleotides and nucleic acids) are becoming available for enzyme studies.

One of the most important and interesting articles in the series under review is that by Dr. T. Mann on the metabolism of semen. This subject, to which Dr. Mann has, himself, contributed much of great value, has become of considerable significance, and doubtless will achieve greater importance as time goes on. Dr. Mann points out that although it is true that the best way to prolong the life-span of sperm cells is to reduce their motility and metabolism, say, by lowering the temperature, the mammalian spermatozoa are to a large extent independent of the small nutrient reserve they possess. They obtain their energy by assimilation and metabolism of fructose present in the seminal plasma. So far as nutrition is concerned, the spermatozoa "resemble more a culture of microorganisms in a nutrient medium rather than the other animal tissues with their complicated supply of nutrient material via the blood capillaries". Another characteristic of the sperm cell is its remarkably high permeability, which accounts for the high velocity of the exchange reactions taking place between the sperm cells and surrounding medium. Moreover, large molecules, for example, enzymes such as hyaluronidase, can detach themselves from the sperm structure and are released into the outer medium. Perhaps such phenomena are involved in the fertilizing function of the spermatozoa. A detailed account is given of the constituents making up semen, with particular reference to sperm nucleic acid and adenosinetriphosphate and to such enzymes as

hyaluronidase and phosphatases. Fructose and fructolysis in sperm metabolism receive close attention. There seems little doubt that oxidation of carbohydrate predominates over other aerobic processes in these cells, constituting their major source of metabolic energy. A variety of substances other than carbohydrate may, however, be oxidized by the spermatozoa, and it has been claimed, for example, that acetic acid may be a source of oxidation energy for bull spermatozoa. There is very little catalase present in normal bull semen, which may account for the toxicity of hydrogen peroxide to spermatozoa and possibly also for the harmful effect of pure oxygen on sperm motility. There is still insufficient knowledge to appraise properly the relationships between fertilizing capacity and metabolism of spermatozoa; but much progress in this important biological problem is now being made.

"Mechanism of Fertilisation in Metazoa" is the subject of an extensive and authoritative article by Dr. J. Runnström. This deals with the dependence of fertilizability on the physiological state of the sex cells, and on the interacting substances produced by the germ cells. The structural and metabolic changes following fertilization and artificial parthenogenesis are described in detail. Enzyme activation as a major factor in the incitement of development is discussed. Dr. Runnström has recently emphasized the view that development may be dependent on the activation of enzymes, which are controlled in the cell by inhibitors and activators. There seems little doubt that fertilization and enzyme activity are closely connected. For example, Örström contends that fertilized eggs can form glutamine from added ammonia and glutamic acid, whereas unfertilized eggs are unable to accomplish this synthesis but can break down glutamine to glutamic acid and ammonia. Release of calcium, which may occur on fertilization of the eggs, seems to play a decisive part in enzyme activation.

Fat metabolism receives considerable attention in Vol. 8, in articles on the synthesis of lipides by A. Kleinzeller, on the biochemistry of fatty acid catabolism by F. L. Breusch, and on lipoxidase and the auto-oxidation of unsaturated fatty acids by S. Bergström and R. T. Holman. An article on the present status of the "Antifatty-Liver Factor of the Pancreas" by I. L. Chaikoff and C. Entenman may be included in this group. These articles give a clear over-all picture of the state of knowledge on fat metabolism as seen a year or two ago. Dr. Breusch's article on fatty acid oxidations, written in memory of Franz Knoop who carried out the classical work in this field, is particularly welcome. It represents a detailed account of recent work showing the integration of fatty acid and carbohydrate metabolism. Dr. Breusch's own work in this field is described, and his views are put forward with clarity. He shows how recent work gives rise to the conclusion that the greater part of the catabolism of fatty acids in warm-blooded animals is brought about by a gradual interaction of the muscles and kidneys on one hand, and by the liver on the other. It is accomplished in such a way that liver produces acetoacetic acid and β-hydroxybutyric acid from fatty acids by multiple alternate β-oxidation, by way of two-carbon fragments. These acids are then completely oxidized in the muscles and kidneys by way of the C_4-tricarboxylic cycle. Dr. Kleinzeller summarizes recent work on fat synthesis, describing the conditions necessary for fat formation and the various substances from which fat may arise. He discusses mechanisms of fatty acid synthesis and comments on the work that has been carried out on the synthesis of phospholipides, sterols and waxes. He emphasizes the role of the two-carbon fragment in fat synthesis, a process which is becoming increasingly important as work with isotopic carbon as a tracer progresses. Drs. Bergström and Holman deal with the phenomena of the autoxidation of unsaturated fats, a matter of considerable practical as well as biological importance. The antioxidants, and the possible role of tocopherol in this connexion, are discussed. The new conception in nutrition that fatty livers may arise from a deficiency of labile methyl groups in the diet is the subject of study in an interesting paper by Drs. Chaikoff and Entenman. They go fully into the problem of the interrelationships between choline, methionine and the factors present in the pancreas that affect fat formation in the liver.

Snake venoms are the subject of an article by Dr. E. A. Zeller. He describes the presence in venom of a variety of hydrolytic enzymes, including choline esterase and hyaluronidase, and he points out that *l*-amino-acid oxidase (which differs from the mammalian variety) is the only non-hydrolysing enzyme so far found in snake venoms. Many lesions of brain and nerve are caused by snake venoms, the attack of the neurotoxins being directed towards different parts of the nervous system. There seem to be good reasons for believing that enzyme processes are involved in the action of the neurotoxins; but there is little exact information, and no clear relationships are yet established.

Dr. R. F. Dawson writes a valuable account of the present knowledge of alkaloid biogenesis. He deals with the origin, development and accumulation of alkaloids such as nicotine, *nor*-nicotine, anabasine, hyoscyamine, hyoscine and the cinchona group. Mechanisms of synthesis are discussed, and there is an interesting section on the relations between alkaloid synthesis, protein metabolism and plant physiology.

The dehydropeptidases receive expert treatment at the hands of Dr. J. P. Greenstein. These enzymes act specifically upon peptides containing an α-β double bond adjacent to the substituted amide bond, and are distinct from the peptidases such as dipeptidase, carboxy peptidase, etc., that catalyse the hydrolysis of the peptide bond uniting the normal saturated α-amino-acids. The dehydropeptides promise to be of considerable importance in metabolic processes, and Dr. Greenstein's article is most timely.

Limitations of space alone forbid more than mention of the very valuable articles by Dr. M. Heidelberger and Dr. M. Mayer on quantitative studies on complement; Dr. F. F. Nord and Dr. J. C. Vitucci on the microbiological degradation of cellulose; Dr. H. E. Street on nitrogen metabolism of higher plants; Dr. A. D. McLaren on the effects of light and radiation on enzymes, hormones and viruses; Dr. A. E. Stearn on the kinetics of biological, especially enzymic, reactions; the late Dr. L. Michaelis on reversible step reactions; Dr. D. Glick on the principles of cytochemistry; Dr. T. K. Walker on acid formation in fungal metabolism; Dr. M. A. Joslyn on enzyme activities in refrigerated vegetable tissues; and by Dr. A. Hesse on the industrial biosynthesis of fat. These articles are all of the highest standard, and no research worker in the biochemical or enzymological field can afford to neglect them.

J. H. QUASTEL

GENETICAL THEORIES

The Elements of Genetics

By C. D. Darlington and K. Mather. Pp. 446. (London: George Allen and Unwin, Ltd., 1949.) 25*s*.

IT is with the highest expectations that one opens a book with such a title written by two such authors —Dr. C. D. Darlington, whose creative imagination has done more to advance cytogenetics than that of anyone else alive; and Dr. K. Mather, a recognized master in the discovery and handling of solid facts. The first sentences of the preface, with their promise of speculations to come, only whet the appetite; and enthusiasm may even carry one without a qualm past the second paragraph, with its minatory boast that the doubter "will do well to recollect that this is the first attempt to represent the whole scope of genetics, the whole of what has always been needed".

But when one settles down to read the book, it is not easy to decide what one is expected to look for, or what one can hope to find in it. The first chapter is devoted, as though it were to be a text-book, to the fundamental notions, such as genotype and environment; but the authors choose to demonstrate the importance of the nucleus by quoting Boveri's old experiments in which enucleated sea-urchin eggs were fertilized by sperm of a different species and developed almost purely paternal characteristics; and the unwary student will not discover until Chapter 8, if he retains his critical faculties so long, that this is by no means a general phenomenon, but was used as a debating point to win his untutored consent to a general proposition; in this case, of course, to one which is in the main justifiable. This is, however, only one case out of many in which the authors seem to have failed to take the trouble to produce arguments which are genuinely convincing, either in the light of the known facts or even as questions of simple logic. A similar off-hand manner is shown by the treatment of other authorities. A few references for details of fact are given at the end of each chapter, and the book includes a list, presumably exhaustive, of all genetical books published in English; but these completely unselective citations serve only to conceal the names of those to whom the credit for the development of genetics should really go. What is one to think of a rather full treatment of quantitative inheritance and the theory of natural selection which makes only passing mention of Fisher and none at all of Haldane or of Wright?

One comes to the conclusion that the only logical coherence the book possesses is in the very broad outlines of its arrangement, into parts dealing respectively with individual differences, the genetic determinants of these, and the relations between individuals within populations. One must take it as a series of personal opinions within this loose framework. Its value, then, should not be sought in precision of argument or orderliness of presentation, but in the vividness and novelty of the opinions expressed. We can accept with a smile the rhetoric which leads to the statement that genes "act backwards, as well as forwards, in development" (hastily qualified, one suspects by the other author, by the remark that this is, of course, only a figure of speech), because the phenomena in question actually raise some interesting problems of enzymatic dynamics.

The undaunted reader will be rewarded by much that is stimulating and some suggestions that are likely to point directly to new lines of advance. As might be expected, the most valuable parts of the book are those most closely related to the authors' own fields of work: the discussion of cytogenetics, of breeding systems and the particular mathematical technique for handling quantitative inheritance which has been chosen for exposition. The least valuable, in my opinion—perhaps because it is farthest from the authors' own researches, or because it is nearest to my own—is the section on development, in which almost the whole weight rests on the postulation of plasmagenes; a hypothesis which has the advantage that we know so little about those largely hypothetical entities that we can endow them with properties appropriate to solve all the problems, but with the disadvantage that much of the evidence for their general importance has lost most of its power of conviction since the book was written.

C. H. WADDINGTON

SCIENCE AND THE SEVENTEENTH CENTURY

The Origins of Modern Science, 1300-1800

By Prof. H. Butterfield. Pp. x+217. (London: G. Bell and Sons, Ltd., 1949.) 10*s*. 6*d*. net.

THIS book is of interest and value, not only to the general reader and historian of science, but also to the philosopher, the theologian and the man of letters. The author is professor of modern history in the University of Cambridge and brings a wealth of background knowledge and historical insight to the problem of the origins of modern science. As a result, the seventeenth century is portrayed in its true perspective as the culminating period of the scientific revolution which had its beginnings some two or three centuries earlier.

"The Origins of Modern Science" consists of lectures delivered for the History of Science Committee in Cambridge in the Lent and Easter terms of 1948, now "reproduced in the hope that they may interest the historian in a little science and the scientist in a little history". As indicated in the sub-title, "1300–1800", the period surveyed extends from the fourteenth century, when the Aristotelian explanations of motion were being challenged, to the end of the eighteenth century, when the foundations of the theory of evolution were being laid.

In the first chapter Prof. H. Butterfield directs attention to the historical importance of a theory of impetus—the tradition of the fourteenth-century Parisian school represented by Nicholas of Oresme—whereby a projectile was thought to be carried forward by an actual impetus it had acquired from the mere fact of its being in motion. Later, the works of Copernicus and William Harvey are discussed, and the chapter on experimental work in the seventeenth century has special reference to Galileo. A little farther on there follows a well-balanced account of the history of the modern theory of gravitation. The new habits of mind that emerged had their repercussions on the life and society of the seventeenth century, and in this connexion Prof. Butterfield gives due prominence to Fontenelle's biographical sketches concerning the social successes of the sciences in the reign of Louis XIV. At the end of Chapter 10, which deals with the place of the scientific revolution in the history of Western civilization, the author summarizes

his conviction that "what was emerging towards the end of the seventeenth century was a civilisation exhilaratingly new perhaps, but strange as Nineveh and Babylon. That is why, since the rise of Christianity, there is no landmark in history that is worthy to be compared with this." The last two chapters are concerned with the eighteenth-century scientific revolution in chemistry, and with the ideas of progress and evolution which prepared the minds of men for the "Origin of Species" in 1859.

It is a tribute to the author that the presentation of his theme stimulates the reader to more detailed study; the value of "The Origins of Modern Science" is enhanced by a list of suggestions for further reading.

H. D. ANTHONY

PEASANT WORK AND WORSHIP IN THE DECCAN

The Aboriginal Tribes of Hyderabad

By Dr. Christoph von Fürer-Haimendorf, in collaboration with Elizabeth von Fürer-Haimendorf. Vol. 3: The Raj Gonds of Adilabad, a Peasant Culture of the Deccan; Book 1: Myth and Ritual. Pp. xvii+450+52 plates. (London: Macmillan and Co., Ltd., 1948.) 35*s.* net.

AN important gap in our knowledge of the aboriginals of India has been here filled by Dr. C. von Fürer-Haimendorf, for, though Grigson and Elwin have written authoritative accounts of the Gonds of Bastar State, there was previously no comparable work on those of the Central Provinces and Hyderabad. The Gonds, numbering some three million persons, are the largest aboriginal group in India and, as is to be expected, contain many diverse elements and display levels of culture ranging from the most simple to that of the court of a Hindu raja. The author has selected for his subject the primitive and important group inhabiting the Adilabad District between the Godavari and Penganga on the north-eastern border of Hyderabad State. Here more than seventy thousand of them live, preserved, as the author points out, by many years of Moslem rule from the more aggressive elements of Hindu culture. The author and his wife lived among these people for long periods as trusted friends and toured over the whole area. It is their record of what they actually saw, aided by superb photographs, which gives such a fascinating vividness to their account.

The present volume deals with the myth and ritual of the Gonds of the uplands, where the ancient culture is best preserved, and contains also a full account of the Pardhans, who play an essential part as hereditary bards of the Gonds and guardians of their songs and traditions. The tribal myths are no dead relics of the past. They are alive, and without a knowledge of them it would be impossible to understand Gond society; to a Gond the Persa Pen, the 'great god', of his phratry is as real as the founder is to members of an Oxford college. The author was therefore right in recording the full texts of the myths; they are of the utmost value, but it may be suggested that, placed as they are, they tend to interrupt the narrative of the book, so that the ordinary reader would have found it more convenient if they had been relegated to appendixes and their present place taken by condensed and analysed versions.

In course of time the phratries split up into clans and sub-clans, each with its own Persa Pen symbolized by an iron spearhead, a whisk (curiously enough of yak hair), brass bells, a bamboo stave and a cloth, and anthropomorphic idols playing no part in the ritual. Around the simple Persa Pen shrines a most elaborate ritual centres, and the author's first-hand account of the Persa Pen Feast at Marlavai in 1942 is bound to be a *locus classicus* of ethnography.

In the latter part of the book, the annual cycle is described, beginning early in the hot season with a rite corresponding in some ways to the Holi festival of the Hindus, but particularly important for the reason that all who partake of the ritual food affirm the unity of the community by placing themselves under an obligation not to move to another village until after the harvest. At this feast, too, every householder fells a bush or small tree, in memory of the old days of shifting cultivation, and until the ceremonies are over no ploughing may be done. In May, jungle fruit is ceremonially eaten and the ban on its export from the village lifted, and at the same time all the phases of the old agricultural year of shifting cultivation are dramatized with the object of ensuring a good harvest. At this time the great feasts of the clan deities described earlier in the book are celebrated at the full moon, usually preceded by rites in honour of family gods. At one of these, witnessed by the author, a seer in a state of trance was at his own request lashed again and again with whips without showing any sign of pain or bruising. As soon as the rains have really broken, a ceremonial First Sowing takes place, followed by a period of intense activity, for delay in sowing the fields would spell disaster. In June or July another ceremony takes place at which the deities are asked to protect the wandering cattle of their herdsmen, and the ban is lifted on the blowing of horns, the noise of which, it is believed, would have injured the grain when it first began to germinate. In August or September the first fruits are eaten and the harvesting of the small millet begins. The cool season is now at hand and dry weather crops are sown, all of them dating from the time when the Gonds abandoned shifting hill cultivation for plough cultivation in the valleys. Once that work is over, the time arrives for wandering troupes of dancers to entertain the villagers with songs and boisterous pantomimes. It is the time of greatest gaiety for a happy people; but it is not allowed to last long, for the great millet is ripening and has to be protected from birds and marauding deer and harvested in time for a short rest before another strenuous year begins.

It was while serving as adviser to H.E.H. the Nizam's Government for tribes and backward classes that Dr. Haimendorf collected the material for this monograph, and it is good to know that under the present regime he still retains a connexion with the State, and that the measures he proposed for the protection and advancement of the aboriginals are being largely carried out. Many points in Gond culture are obscure, and though an explanation of some of them may be possible when other sections of the tribe are studied, the author is right in leaving a number of questions unanswered for the present. His careful field-work and wide experience have produced a book of the highest value and interest, both to the anthropologist and to the general reader, and the second volume will be eagerly awaited. The publishers have fully maintained their high standard of production, and the price is surprisingly low.

J. P. MILLS

England's Dances

Folk-Dancing To-day and Yesterday. By Douglas Kennedy. Pp. 158+16 plates. (London: G. Bell and Sons, Ltd., 1949.) 7*s.* 6*d.* net.

MR. DOUGLAS KENNEDY is the director of the English Folk Dance and Song Society, and as such knows his subject. He has written a delightful little book of some 158 pages with twenty illustrations and two distribution maps. Dancing throughout the ages has been for humanity a psychological release and has been continually used in ritual, both religious and otherwise. Shortly after the first use of mustard gas in the First World War, an American hospital unit took over a complete British tented hospital in Rouen. The strain of the personnel was very great; but it was completely relieved by the introduction of dances. Dancing was the channel for release of the overwrought emotion.

A popular study of English folk-dances and their origin and distribution should be seriously welcomed and should command attention, even from those who are not particularly interested in dancing itself. Following a short introduction by Dr. Vaughan Williams, Mr. Kennedy starts by giving an account of the discovery and revival of a number of ancient folk-dances up and down the countryside. There follows a brief study of the primitive dance and its importance in man's psychological make-up. "The primitive dancer engaged in communicating his vitality by leaps and stamps is himself brought under the spell of rhythm and loses his own self-conscious identity. He becomes, in fact, possessed and ceases to be himself, and the ritual that enwraps him turns him into an actor."

Two seasons of the year were notably connected with special dances—the mid-winter and early spring. The former is associated particularly with the sword dance, the latter with athletic dances performed by young men. "The young men leap and stamp—their rhythmical actions are emphasized by the sound of bells and by the fluttering ribbons. The whole effect, even to the most sceptic observer, is one of tremendous vitality." The connexion between the energy of the world awakening after the winter rest and the energy of the young men is obvious.

It is impossible in a short note to describe in detail this little volume, packed full as it is of factual matter; but I should like to stress, what Mr. Kennedy has well brought out, that the English folk-dances had a meaning—they were, and should still be, the expression of something fundamental to human nature.

M. C. BURKITT

Grundriss der allgemeinen Zoologie

Von Alfred Kühn. Zehnte verbesserte Auflage. Pp. vii+281. (Stuttgart: Georg Thieme, 1949.) 18 D. marks.

THE tenth edition of Dr. A. Kühn's outlines of general zoology has been much altered, both as regards text and illustrations, since the first issue in 1922. It is a bold attempt to give students, especially medical students, some idea of the more general aspects of zoology, in order to stimulate their interest and to stress the importance of special branches of the subject, such as experimental embryology, parasitology and the philosophical conclusions arising from the study of animal life.

A third of the book is devoted to a survey of the animal kingdom, providing the necessary basis for the comparative chapters which follow. Physiology, cell division, maturation, the Mendelian and chromosome theories of heredity, the organisation centre and the development of the animal body are soundly treated. The conditions of animal life in aquatic and aerial media, parasitism and symbiosis are briefly dealt with, and the book ends with a chapter on the species problem, a short and almost wholly German bibliography, and an index. The text is a reliable commentary on modern zoological science. It is surprising to find that the elephant is given 150–200 years of life (p. 247), since all authentic records estimate it at seventy years.

The illustrations are clear and well chosen, especially some of the schematic diagrams and the series of skeletal comparisons. The paper on which they are printed, however, is not very good, and they show through the pages with a peculiar yellowish tinge. Fig. 124*a* is printed upside down. The book can be recommended as a short survey of the various fields of zoology to-day.

A Textbook of Systematic Botany

By Dr. Deane B. Swingle. (McGraw-Hill Publications in the Botanical Sciences.) Third edition. Pp. xv+343. (London: McGraw-Hill Publishing Co., Ltd., 1946.) 30*s.*

ALL those concerned with the teaching and learning of systematic botany in Britain will welcome the appearance of a third edition of Prof. Swingle's well-known text-book, especially as in recent years interest in taxonomy at our universities has considerably increased. "Most of the chapters have been thoroughly revised and amplified, some almost entirely rewritten, and a new one has been added on methods of identification." This revision includes an elementary introduction to the new 'experimental method' in taxonomy and references to literature where further study can be made. The field covered by Prof. Swingle is comprehensive, but it is to be regretted that, even in an avowedly elementary text-book, no room is found for a hint of the difficulties involved in regarding a 'natural' classification as identical with a 'phylogenetic' one. Some warning to students that the subject is not so simple as it seems should surely be given, and some direction as to where the considerable discussions that have taken place on the philosophical background of the problem can be found.

J. S. L. G.

Kinetics of Chemical Change in Solution

By Prof. Edward S. Amis. Pp. ix+332. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1949.) 25*s.* net.

IN the reviewer's opinion this is a very successful book. It presents the basic material in a really adequate way and contains a large amount of information. Special attention is given to the theory of electrolytes and dielectrics. The modern treatment of reaction-rates is fully developed, and cases of real practical importance are chosen for consideration. The mathematical treatment is often full; but in many cases steps are passed over without adequate indication that anything is missing, and the volume contains a surprising number of misprints in the formulæ and equations which may cause trouble to students. The topics include photochemistry and catalysis. The literature references are very full, and adequate attention is given to non-American sources, which puts the book in a class of its own. It can be cordially recommended.

J. R. P.

STATE-AIDED RESEARCH IN FRANCE AND FRENCH SCIENTIFIC INSTRUMENTS

ON February 8, M. Jean de Sailly, Commercial Counsellor to the French Embassy in London, opened at the Science Museum, South Kensington, London, an exhibition of French scientific instruments. M. de Sailly remarked upon the international character of the event, which was made possible only by the closest co-operation between British and French interests. This is the first time in many years that it has been possible for the scientific tools of another country to be examined in detail by a wide scientific public in Great Britain.

Any narrow nationalism in science is to be deplored, but a country which finds it excels in some art or skill may take legitimate pride in it. As Prof. E. N. da C. Andrade observed at the opening ceremony, the French technician exercises his æsthetic judgment in his final designs, which results in an elegance which accords well with the requirements of precision. The exhibition exemplified this principle at many points, and it showed, moreover, how the traditional French genius in optics and mechanics is in no way diminished in the newer fields of electrical technique.

A second aspect of the exhibition was perhaps more significant in the wider view of world science. It is a commonplace that the team has virtually supplanted the individual in much scientific endeavour, and it is further evident that in some branches of scientific study, neither team nor individual can long survive without the patronage of the State or of organised interests of comparable size. It was therefore of more than passing interest to see the exhibition reproduce in miniature the organisation of State-aided research in France. Thus, apart from the contribution of some individual instrument manufacturers, some bearing old and honourable names, there were to be seen main sections from some of the leading French official research agencies.

After the opening ceremony, Sir Ben Lockspeiser presided at the delivery of two addresses on the official organisation of science in France, by Prof. Edmond Bauer, professor of physical chemistry in the University of Paris, and M. Volkringer, head of the Inventions and Patents Department of the Centre National de la Recherche Scientifique. From their surveys one can extract a general picture.

State-aided research in France has a long history, and it has always extended as much to humane studies as to natural science. Indeed, the history can be traced as far back as the foundation of the Collège de France by François I in 1530. There followed the foundation of the Museum of Natural History in 1626, the Observatory in 1667, and the Academy of Sciences in 1666. The Revolution saw the reorganisation of the French universities, and the emergence of the Grandes Ecoles for higher technical education.

The time passed when important research could be done with inexpensive equipment, but no aid was given by the Government until the First World War produced a change in official attitude. At the end of 1915, a Directorate of Inventions was set up for subsidizing war research, a notable outcome being the work of Langevin and Schilowsky, whose system of submarine detection is perpetuated in the ASDIC system.

After 1918, French government support for science again declined until 1930, when a National Scientific Fund was formed through the enlightened collaboration of Jean Perrin and Edouard Herriot, representing respectively the worlds of science and of politics. A period of development and adjustment followed, culminating in 1939 in the fusion of bodies previously devoted separately to pure and to applied research into the Centre National de la Recherche Scientifique. The Second World War and the German occupation failed to destroy the Centre, and it finally achieved its present-day form under Prof. F. Joliot.

The tradition of subsidizing research in humane studies as well as in natural science continues, and a balance is struck between pure and applied research.

The line of historical development has led most directly to the Centre National de la Recherche Scientifique; but no single agency can represent the whole body of scientific effort. It is natural, therefore, that the past twenty years should have seen the growth of other official research agencies in France, and it is tempting to look for parallels with British practice. The temptation must be resisted, however, since national needs and opportunities have differed too much for any very close resemblance to exist. With the important difference that the Centre National deals with humane studies, we may liken it most closely to the Department of Scientific and Industrial Research in Great Britain, but, as will appear, the analogy is not complete.

The Commissariat à l'Energie Atomique has broadly the same terms of reference as the combined atomic energy divisions of our Ministry of Supply. The Office National d'Etudes et de Recherches Aéronautiques resembles the Royal Aircraft Establishment in its experimental studies and in its link with national defence organisation, but its liaison with the Centre National is closer than that between the two British bodies.

The Centre National d'Etudes des Télécommunications must not be compared too closely with the Telecommunications Research Establishment in Britain, nor the Institut du Pétrole with the Fuel Research Station, but it is sufficient to say that there is much common ground. The Institut National de la Recherche Agronomique and the Institut National d'Hygiène are both young organisations, and have not yet the experience of the Agricultural Research Council and Medical Research Council, but the possibilities of development are clear. Their growth will be watched with interest and sympathy in Great Britain.

Full maturity has been reached only by the Centre National, and it is the chief single influence in the scientific life of France to-day. Although attached to the Ministry of Education, it is financially autonomous. In 1949 its budget was about two and a half million pounds. Its total staff numbered 2,800, of whom about 1,000 had a status equivalent to the 'scientific officer' grades in the British Scientific Civil Service. It has thirty research laboratories, the most important being at Bellevue, with a staff of about 350. It has certain specialized services, such as a breeding centre for experimental animals, a

training service for research workers, a documentation service, and an inventions service.

The documentation centre not only publishes its own material, but also subsidizes the publication of books and periodicals. It publishes a *Bulletin Analytique*, an abstracting journal with two unique features. It not only covers all the objective sciences, but has also a section devoted to philosophical studies, and it notifies unpublished matter deposited in the archives of the Centre National.

The Commission des Inventions has some kinship with the National Research Development Corporation in Britain; but may fairly claim at the moment to be in some respects the more advanced. It gives assistance to inventors from the Centre National, or from outside bodies, or to individuals, in all forms from technical advice to financial help in exploitation. Its small budget (some £10,000 last year) limits its scope, but it is dealing with some four hundred inventions annually, and it can initiate special grants, such as that made for the development of the calculating machine of the Institut Blaise Pascal.

Such in outline is the form taken by official research organisations in France; further information can be obtained from the Scientific Office of the French Embassy, 58 Knightsbridge, London, S.W.1.

Organisation does not make research, and the efficacy of the French plan must be judged by results: advances in natural knowledge, advances in material well-being, the overall balance between different fields, and so on. At the least, one may be grateful that the exhibition at the Science Museum has provided an opportunity of judging one other type of result, namely, that of advances in instrumental technique.

Instrument design is subject to fashion, and as new materials and resources become available, style and external appearance change. French fashion would appear now to favour bright colours, open access, easy substitution of alternative components and a much more robust construction all round than we have expected from commercial French instruments in the past.

Design, of course, is partly an individual function, partly a matter of influences, and it is more than amusing to note the differences in style between the different groups. One may certainly detect an American element in the atomic energy exhibits. The subject-matter is irrelevant here. The influence is seen in such details as style of name-plate, shape and size of control knobs and much else which reflects mere habit—a reflexion in turn of the close association which specialists in this field had with British and American activity for so long.

Although outside influences are apparent in the section contributed by the French instrument industry, family tradition, allied with long Continental practice, gives many of the instruments shown an unmistakable character.

These are superficial considerations. The technical accomplishment of French instrument technology is demonstrated by the Fonbrune micromanipulator, the Desvignes monochromator (which uses a single element but is comparable in performance with a double monochromator of conventional design, and has higher luminosity), an excellent recording microphotometer, a compact short-period seismograph, a single-cylinder experimental internal combustion engine for combustion and lubrication studies, and a micro tensile test machine for studying the properties of single fibres. In all these, fitness for purpose is clearly evident, as it is in many of the other instruments displayed. It is this same quality which gives interest to many other instruments for which no claim of originality is made; for example, the analytical mass spectrograph and the multi-unit polarograph shown by the Commissariat à l'Energie Atomique.

The narrow spaces of an exhibition stand focus attention on the laboratory-bench aspect of experimental technique; but one must remember that some investigations necessarily require apparatus of large dimensions. A set of photographs, some striking for the beauty of the photography, showed the Modane high-speed wind-tunnel project of the Office National d'Etudes et de Recherches Aeronautiques. The size of the budget for this enterprise—some millions of pounds—will remind us that the French can match elegance with boldness when the aim is clearly conceived.

The lasting results of this exhibition cannot be assessed yet. Its appeal was not to the large majority looking for handy routine tools, but rather to the few who seek help in seeing science whole. If, as has been suggested, an exhibition of British scientific instruments is held in Paris, the other half of a pattern of joint effort will fall into place. As near neighbours, Great Britain and France have no choice but to collaborate in many spheres. Collaboration and understanding in the sphere of science hold a potential for good which exhibitions of this sort do much to advance towards ultimate realization.

FRANK GREENAWAY

YUKON–ALASKA EXPEDITION OF THE ARCTIC INSTITUTE OF NORTH AMERICA

By PROF. N. E. ODELL

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DURING this past summer (1949) the Arctic Institute of North America (New York branch) organised the second instalment of its programme of field research within the high interior of the St. Elias Range on the international boundary between Yukon Territory and Alaska. The first instalment took place during the field-season of 1948, and a summary of the results attained are given by Walter A. Wood, the leader and organiser, in *Arctic* (1, No. 2; 1948), the journal of the Institute. Referred to as "Project Snow Cornice", the object of this enterprise was glaciological work, as well as geological and meteorological, in a region scantily known and notoriously inaccessible. But the prime motive in the first instance had been programmes of intensive glaciological investigation, such as those which have been conducted in Europe, Greenland and Spitsbergen under Scandinavian, British and Swiss auspices, and which have been lacking so far anywhere in North America.

A high intermontane basin within the St. Elias Range, situated on the Yukon side of the border, and occupied by the Seward Glacier (or firn-field, *sensu stricto*), was chosen as the most suitable locality for these glaciological observations. Such an area of accumulation, approximately 750 square miles in

extent, which is the main feeder of the great piedmont Malaspina Glacier, appeared admirable from the point of view of modern glacier-regimen studies. However, such an inaccessible and difficult region, sixty miles at least from the coast, can only in practice be approached or utilized for this purpose by the employment of aircraft. A 'Norseman' aeroplane, fitted with special retractable wheel-ski landing gear, was the answer to the transport problem, and in the hands of the experienced 'bush' pilot, Maurice King, it fulfilled all expectations, even to the extent ultimately of having its possible 'ceiling' improved to an altitude of more than fifteen thousand feet, when in the process of reconnoitring Mt. Vancouver.

From a coastal base at Yakutat, with its airfield of the Civil Aeronautics Authority, the first flight was made in mid June up to the Seward firn-field, where again was established an advanced base for the work of the Expedition. Situated at an altitude of about six thousand feet, nearly fifteen feet of snow had fallen in this locality during the winter of 1948–49, as we were able to determine during the excavation of a cache of stores left in 1948; but precipitation must be heavy at all times in this region. At Yakutat on the coast the average over forty-two years has been 134 inches of rainfall, with a highest annual of 168 inches within that period; while during July 1, 1948–July 1, 1949, as much as 162 inches was recorded.

It was in the vicinity of our 'airstrip' camp on the Seward firn-field that a great part of the glaciological researches was carried out under the direction of Prof. R. P. Sharp, of the California Institute of Technology. These investigations, in continuation of those conducted during the summer of 1948, comprised thermal regimen, firn density and structure, free-water content, melt-water movement, ablation and accumulation. Measures of the thickness of firn and glacier-ice were determined, or attempted, by seismic survey, radar, and gravity meter, but the present technique used, in the case of radar in particular, has so far proved unsatisfactory. Prof. Sharp and his party of five specialists have yet, of course, to analyse fully all their field observations and results. But a promising start has been made with what it is hoped may be a long-term programme of glaciological research to be continued in subsequent seasons on the Seward firn-field as and when circumstances permit.

On the Malaspina Glacier itself, in the vicinity of the coastline, Dr. Henri Bader carried out some crystallographic and structural studies of the stagnant ice of this piedmont mass, and it is anticipated that some interesting results may accrue from these investigations, which it is hoped may be continued in the future. A feature of special interest here is the heavy growth of sitka spruce and western hemlock trees, up to seventy-five feet high and thirty inches in diameter, which has colonized the marginal tract of the Malaspina Glacier. Yet in a convenient exposure it could be seen that the ablation mantle of moraine and debris covering the ice, upon which these large trees were growing, had an average thickness of only 2–3 feet. A number of these trees were cored by a Swedish increment borer, and their ages were found to vary from about fifty years to as much as ninety-nine years in the case of the oldest discovered.

As to the solid-rock geology, with which I was principally concerned, an examination was made of many 'island' outcrops in, as well as the great mountain walls surrounding, the Seward firn-field from our advanced base situated on a nunatak, or rognan, near the foot of Mt. Vancouver. It was sometimes necessary to travel a dozen miles or more on skis over the surface of the vast firn-field to reach particular outcrops, and bad weather and adverse terrain often hampered both topographical and geological mapping. The services of our aeroplane were called upon for visiting the remoter areas to the westward and northward, although conditions of landing on the snowy or icy surface were at times very difficult and required the utmost judgment. In brief, it can be said that the heart of the St. Elias Range consists of a metamorphic series of sedimentary origin, mainly pelitic and calc, and in all probability of Palæozoic and Mesozoic age. Into this series has been intruded an igneous facies which varies from granite to grano-diorite and diorite, and it is usually gneissose in structure in the field. A later suite of dolerite dykes cuts the whole complex. The immense mountain masses of Mt. Logan, 19 850 ft. (the highest summit in Canada), Mt. St. Elias, 18,008 ft., and Mt. Vancouver, 15,800 ft., are examples of such acid intrusive occurrence, which by their greater durability, aided possibly by differential uplift, have maintained their pre-eminence. In the case of Mt. Vancouver, of which four of us made an arduous eight-days' ascent, and until then the highest unclimbed mountain in North America, it was found that the summit outcrops consisted of a particularly tough arkose or greywacke, much fortified by local aplitic bodies.

It is of interest to recall that as long ago as 1891–92 Prof. I. C. Russell crossed the Malaspina ice-sheet and examined the southern flanks of the St. Elias Range, and in doing so he made the important discovery of Pleistocene (and Pliocene ?) beds having been elevated to some five thousand feet above sea-level. But no one has since followed up his important work. That great elevation has taken place in this region seems to be beyond doubt. Moreover, there is evidence otherwise to suggest that this was, at least in part, probably subsequent to the waning of the much greater Pleistocene glacierization, which appears to have filled the Seward basin to a thickness at least five thousand feet in excess of that of the present day. On the western ridge of Mt. Vancouver I found a moraine-like deposit as high as thirteen thousand feet; but this I am disinclined to regard as firm and unequivocal evidence of the maximum stand of the regional ice-sheet.

Space does not here permit of more than mention of the other interesting discoveries made in the course of the work of the Expedition. The fact that spiders, butterflies, moths, a variety of birds, including even humming-birds, should be found in these remote, frigid and elevated mountain fastnesses, apart from a whole range of alpine and arctic plants, mosses, etc., raises all kinds of questions of migration and indeed origin. Not the least curious discovery, made by me near a camp at about six thousand feet beneath the immense southern wall of Mt. Logan, was that of ice- or glacier-worms, to which occurrence reference has already been made in *Nature* (December 24, 1949, p. 1098). So much mirth and banter has been engendered, even among men of science, by the mention of ice-worms that a peculiar gratification was experienced in this one discovery alone. However, in such a spectacular region there is no need to look for specific thrills, and ice-worms constitute perhaps the least of these.

THE SUTTON HOO SHIP-BURIAL*

By R. L. S. BRUCE-MITFORD

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IN his introduction to the British Museum Provisional Guide (1947), Dr. T. D. Kendrick described this discovery as "the most marvellous find in the archæological annals of England". Subsequent knowledge of the material has shown this to be a just estimate. In outline, the find consisted in the discovery on the east bank of the River Deben, opposite Woodbridge, in Suffolk, buried beneath a tumulus, of a rowing-boat more than 80 ft. long, the central part containing a highly remarkable burial deposit. Of treasure in a strict sense there were regalia and coins of gold and numerous silver vessels; but the many other items in the grave are almost all unique and of the greatest historical value and interest.

The excavation was begun and creditably carried out in the earliest stages under the Ipswich Museum; but the extremely difficult operations of recording and removing grave goods of quite unexpected richness and complexity, in many cases crushed, shattered or decayed, and the great scientific importance which, it was clear, the discovery would have, demanded greater resources, experience and technical skill than were available locally. The excavation was completed by Mr. C. W. Phillips, then a fellow of Selwyn College, Cambridge, and now archæological officer to the Ordnance Survey. Mr. Phillips secured the assistance of some of the ablest figures in British archæology, and of an expert in the history of ship-construction, the late Lieut.-Commander J. K. D. Hutchison, of the Science Museum. It is a most important element in the discovery that it was recorded and observed by skilled professional archæologists, for the last find at all comparable in Britain (and it was a burial of much less importance) occurred in 1883, before the days of modern scientific archæology.

Many of the grave goods deposited in the burial chamber illustrate with a completeness and colour provided by no other find, and equalled among literary sources only in the Beowulf epic, the social life of the Saxon aristocratic hall. The most interesting find in this respect is the small six-stringed maple-wood harp, preserved by the fortunate fact that it had been placed by the burial party in a bronze bowl. It is the first instrument of its kind (a quadrangular harp) to be discovered, a type not hitherto recognized by musicologists, and the earliest reconstructable instrument of post-Roman Europe. There are also the two outsize drinking-horns, with silver-gilt mounts embossed with animal patterns, and fashioned from the horns of the now extinct aurochs. They have a capacity of six quarts. There were five other drinking-horns of normal size (made from ox-horns) and nine tiny vessels with silver-gilt mounts made from the dried skins of scooped-out gourds. The smallest is only 1 in. in diameter and ½ in. high. These must have held something a great deal stronger than the customary mead, beer or wine drunk from larger vessels. The golden treasure and the sword with gold and jewelled mounts, like that borne before Beowulf in Hrothgar's Hall after the slaying of Grendel, and the silver dishes, were also part of the pride and ceremonial of hall-life on occasions of importance. The more strictly domestic appurtenances of the feast are illustrated by three bronze cauldrons, with ornamental wrought-iron gear for suspending them, and three iron-bound wooden buckets.

The forty-five individual items of gold (excluding the coins) constituting the main treasure comprise a ceremonial outfit unparalleled in any other grave. They are fittings of the sword and the baldric on which it was suspended, and of a ceremonial belt. Almost all these pieces are heavily encrusted with garnets. Both technically and in art-historical importance, this jewellery stands higher than any other goldsmith's work of its era that has survived from Germanic Europe. Over and above the perfect assembly, marvellous finish, and sumptuous appearance of all the pieces, is an originality in design, an ingenious inventiveness in technique, a novelty in ornamental themes, and a general feeling that the artist has grown too big for the medium of which he has become past-master, that point clearly forward to the great expansion and flowering of art that distinguishes the latter part of the seventh century in Britain.

The qualities and excellencies of the gold cloisonné jewellery (seen to best advantage in the purse-lid, epaulettes and great buckle, and in the pyramids, scabbard-bosses and pommel of the sword) would alone give the Sutton Hoo find European pre-eminence. Other factors, however, raise it on to the European plane more directly; and it is the remarkable constellation in one closely dated grave in a quite specific historical context of a large number of pieces, not only of the highest significance and quality, but also of the greatest diversity, that gives the find its unique archæological status. Thus although the minting of gold coinage had already begun in Kent and London before the date of the Sutton Hoo burial, none of the thirty-seven struck gold coins in the purse was English. They are all Frankish. Of the thirty-seven, seventeen are 'mint-declaring'. If the mints are plotted it will be seen that they fall within, roughly speaking, the boundaries of modern France, and are distributed all over it. The heavy bronze bowl, with drop handles, in which the remains of the harp were found had travelled more than two thousand miles from Egypt. It was almost certainly made in Alexandria. Four stamps on the bottom of a great silver dish, 27½ in. in diameter, show that it had passed through the office of the Imperial assayers in Constantinople during the reign of the Byzantine Emperor Anastasius I (A.D. 491–518). The fifteen other silver pieces in the grave probably came from regions of the Middle East farther afield than Byzantium. The gourd drinking-cups cannot have had any nearer place of origin than the south of France. These pieces show live connexions between seventh-century Saxon England and southern countries and the surviving sub-classical civilization of the Eastern Mediterranean. But the helmet, shield and perhaps sword reveal for the first time in English archæology direct connexions of deeper significance with a different part of Europe—the Baltic coast of Sweden. Three hanging bowls of thin bronze with enamelled ornamental escutcheons came either from Ireland or from the Celtic west of England.

Perhaps the most important single fact about this find is that it can be closely dated. The limits for the burial, between A.D. 650 and 670, deduced from the coins, ranks as excellent dating for any archæological material of this era.

* Substance of a Friday Evening Discourse at the Royal Institution on October 28.

If, as we have every reason to believe, the Sutton Hoo grave is that of one of the East Anglian kings, this dating margin can be further reduced to the period 654–664, for the three East Anglian kings who died within the larger period (650–670) died in the years 654, 655 and 663 or 664. This precision in dating has a further particular importance in insular archæology in view of the highly complicated art-historical situation in Britain in the middle of the seventh century A.D. At this period we find in progress a creative fusion of Saxon, native Celtic, Irish and Mediterranean elements, and a difference of even a decade either way in the dating of crucial art-documents (such as the Sutton Hoo jewellery) may make all the difference to our interpretation of the course of art development at this time, when British art stood higher than any other in Europe.

The systematic burial of 'grave-furniture' with the dead is a pagan procedure. As the Sutton Hoo burial is the most richly furnished we know, it is in this respect the most whole-heartedly pagan. Yet the burial took place well within Christian times. The general conversion of East Anglia had followed the accession of Sigberht and the establishment by him of a bishopric at Dunwich. These events occurred not later than A.D. 631. Indeed, the grave itself contains clear signs of Christianity, not only in imported objects such as the set of ten shallow cross-bearing silver bowls and the pair of silver spoons bearing in Greek the names Saul and Paul, but also in the locally made jewellery, and, significantly, on the most personal and cherished object in the grave, the dead man's sword. The design of the gold and garnet scabbard-bosses is based upon an equal-armed cross of specifically Christian character. We must also note that these Christian pieces do not occur haphazardly in the grave, but were placed, as with deliberation, at the right side and shoulder of a recumbent body, visualized as lying in the position indicated for the body by the disposition of the grave-goods. If we take this to mean that the dead man was a Christian, and if we still regard him as one of the East Anglian kings (as, among other things, two symbols of office, the giant whetstone and iron standard indicate), serious difficulties arise. It is not so much that the provision of grave goods was a pagan custom, for the Church did not prohibit the practice; but from the first the Church sought to ensure that Christian bodies were buried in consecrated ground, and particularly was this the case with royal families. It would be almost impossible to imagine Anna (one of the three eligible East Anglian kings, who died in 654), a most Christian person, all of whose daughters became nuns and three of them saints, as being buried in the old pagan grave-field at Sutton, when there were numerous churches and monasteries in Suffolk to receive his body. In fact, we know that he was buried at Blythburgh, and that his body was still venerated there in the twelfth century. It is similarly difficult to imagine that the body of another of the three eligibles, Aethelwald (died 663–4), lay here. He was a Christian, godfather to the king of Essex, and died in the year of the Synod of Whitby. It is possible that (if the burial does not represent an unrecorded lapse into paganism) the solution to the dilemma lies in the absence of the body. No trace of any body, even in the form of stains, bone meal or changes in the colour or texture of the soil, could be found by the excavators where it should have lain. An analysis of the positions in which the gold jewellery was found shows that this 'regalia' cannot have been worn on a corpse, either sitting or lying. Other important factors point strongly to the conclusion that the grave never contained a body; but was a cenotaph. If this is so, it is possible that in the great ship-burial we have the public and traditional monument of a king, whose body received Christian burial elsewhere. The Sutton Hoo burial falls just at the close of a heroic age, and in a strange phase of transition between paganism and Christianity. It may be that we have in it another monument typical of this phase, like the Franks casket, with its mixture of pagan and Christian iconography, or the Beowulf epic, in which Christian sentiments and references suffuse older pagan material.

The Sutton Hoo ship-burial is the first intact royal inhumation of its period to have come to light in Europe since the burial of Childeric I, King of the Franks, was discovered at Tournai in 1653. Great importance is thus attached to the application to it of the full range of modern scientific technique and of modern scholarship. In the first place, we have the field technique of the excavators, which enables us, for example, to make an accurate scale model of the Sutton Hoo ship—the earliest English naval vessel—although its timbers had wholly perished, leaving no more than stains and iron rivets in the sand; and which records every phase of the excavations, in addition to plans and notes, in more than a thousand photographic negatives of high excellence. Upon the excavated and recorded materials is brought to bear the resources and experience of the British Museum Research Laboratory, supplemented by a wide range of specialist scientific knowledge and experience from outside the Museum, in botany, zoology, ornithology, geology, human anatomy, metallurgy and other fields. Finally, the material is subjected to the full apparatus of modern historical scholarship based upon the widely ranging researches of many workers in literary, historical and archæological fields. Thus not only is the Sutton Hoo find in itself richer than any other European grave of its era that has come down to us; but we are also able to extract from it vastly more information than has been possible from any strictly comparable European find of its kind in the past.

An illustration of these points is provided by the reconstruction of the Sutton Hoo harp. Its basis is the careful recovery by the excavators of some hundreds of fragments of crushed and distorted wood belonging to the instrument. By re-building and re-assembling two tenon-and-mortice joints in pieces of the main framework, and fitting to it two gilt-bronze plaques with projecting birds' heads, from which ran rivets which held fast the joints, it was possible to re-assemble the framework of the instrument up to a certain point, though without its sound-box or resonator. The result indicated a six-stringed instrument some eighteen inches in height. The wood of the frame was identified as maple in the Department of Botany at the British Museum (Natural History). The stumps of six pegs which came from the peg-holes in the curved arm of the instrument were identified as either poplar or willow by the Director of the Jodrell Laboratory in the Royal Botanic Gardens at Kew. At various points on the maple frame were inconspicuous dark patches. They consisted of hairs and skin, and microscopic examination at the British Leather Manufacturers' Research Association showed that they were from a

fur-bearing animal. Later on, Dr. J. L. Stoves demonstrated that they were beaver hairs. From the distribution of hairs on the frame it was possible to deduce that the harp had been kept in a beaver-skin bag. Inquiry into the stringed instruments of the ancient world showed that they fall into two classes, lyres and harps. The lyres are invariably symmetrically designed about the peg-arm or yoke at the upper end of the instrument, whereas harps are asymmetrically designed about the upper-end or peg-arm. The Sutton Hoo remains belonged to an instrument asymmetrically designed in this respect and therefore to the harp class. In the harp, however, the longest limb is itself a broad hollow box which functions as the resonator of the instrument. In the Sutton Hoo instrument this limb is thin and solid. The instrument must have had a resonator to function at all, and the only solution that the surviving remains allowed was that it had been of quadrangular form with the resonator at the bottom. Notes made when the remains were excavated showed that this portion of the instrument would have projected at the top of the bronze bowls in which the remains were found, and a large number of fragments of thin maple sheeting taken from the top of the bowls proved to be the remains of a capacious sound-box. For the solution of many remaining problems of detail, a practical approach was necessary. Musicologists were consulted, and experimental models were made in the workshops of Messrs. Arnold Dolmetsch, Ltd., at Haslemere. An experimental playing reconstruction, attained through study of the remains and experiment, was confirmed by research among early illustrations. An eleventh-century Anglo-Saxon MS. in St. John's College, Cambridge, for example, showed in use an instrument of the same kind as the Sutton Hoo harp. The fact that it is held by a second person, and that the player is touching the strings from both sides, showed that it is an open-stringed instrument of harp-type, with a resonator at the bottom, and not a vertically held frame (psaltery) with sounding-board behind the strings. There is no direct evidence for a tuning key among the Sutton Hoo remains; but the use of such a device was inferred from the fact (only ascertainable by experiment) that even when the heads of the pegs were made of the smallest size that would allow the fingers to get a purchase on them, the spacing of the peg-holes was so close that, when two adjacent peg-heads came nearly horizontal, it was impossible to pass the fingers between them. Justification for this inference was later found on the ivory cover of a twelfth-century manuscript in the British Museum, on which a musician may be seen tuning an instrument of the Sutton Hoo type with a small key.

The harp as reconstructed has a charming tone, and wide melodic range, and simple harmonies can also be performed on it. To ears accustomed to brass bands and the ninety-piece orchestra it sounds surprisingly soft; but this softness is a true characteristic of primitive stringed instruments, and is to be found, for example, in the shoulder-harps of ancient Egypt or the recent clavichord.

The Swedish connexion in the Sutton Hoo find provides a good example of its European implications. The common custom of boat-burial, confined at this period to Suffolk and Uppland, and certain material from Sutton Hoo, show that we are not dealing with casual gifts or imports, but with a deeper connexion. It is too early to interpret this connexion with authority; but it has been suggested that the East Anglian royal house (the Uffingas) may prove to be in origin a branch of the royal house of Uppsala. This connexion is an entirely new fact in English history, to which documentary sources give no clue. The intimate character of the archæological links may be indicated by the fact that one of the scenes on the Sutton Hoo helmet was only reconstructed with the aid of an identical scene on a helmet newly excavated in Sweden, and that gold cloisonné pyramids like those that decorated the sword-knot of the Sutton Hoo sword have so far been found elsewhere only in the great royal mounds at Old Uppsala.

Years of study and digestion lie ahead before the full significance of the Sutton Hoo discovery will be understood. What we already know of it well illustrates the great potential historical value of archæological material, even within the framework of comparatively recent history. A monument such as this, both in general interpretation and the wealth of concrete detail it provides, brings the modern student in many ways into living touch with seventh-century life and history, where other documents do not exist, remain tantalizingly silent, or singularly fail.

NEWS and VIEWS

Prof. J. E. Littlewood, F.R.S.

Prof. J. E. Littlewood, the first holder of the Rouse Ball chair of mathematics at Cambridge, will vacate it this year on reaching the age of sixty-five. A pupil of F. S. Macaulay at St. Paul's School, he learned as a boy to distinguish between vital ideas and examination tricks. Going to Cambridge, he realized that preparation for the tripos would consist largely of acquiring a repertoire of tricks, but decided that it was a game that he could play as well as his contemporaries, and he was bracketed senior wrangler in 1905. He lost no further time before plunging into real mathematics, and he proved some deep results about integral functions. He spent three years at Manchester and returned in 1910 to a fellowship and lectureship at Trinity College, Cambridge; he was elected professor in 1928. After the triumph of the Abel–Tauber theorem (1910) he began his long partnership with Hardy, a partnership without parallel in the history of mathematics. Among the topics to which they made major contributions in the course of thirty years are convergence and summability of series, trigonometrical series, inequalities and the analytic theory of numbers.

Littlewood has done much work independently, mainly in complex-function theory, and he has collaborated on a large scale with Paley, Offord and Miss Cartwright. A mathematician of the front rank normally produces, apart from his finest theorems, work which a reader feels has not really stretched him. In the pages which Littlewood has written, running into thousands, there are remarkably few which could have been the work of anyone else. He has distilled the essence of years of lectures into two highly individual books, "Elements of the Theory of Real Functions" (1926) and "Lectures on the Theory

of Functions" (1944). During the First and Second World Wars, he solved a number of mathematical problems directed to what he called trivial purposes. In the former of these two periods he was a second-lieutenant in the Royal Artillery; but it may be assumed that he avoided the menial tasks which usually fall to subalterns.

Littlewood is a legendary rather than a public figure; when he has travelled abroad, it has been for athletic interests and not to talk mathematics. But he has started many young men in research. They get from him no gifts of easy problems, but boundless encouragement to try the hard ones: "If you don't solve *that* problem, it will lead you on to another one". Elected to the Royal Society at the age of thirty, he received a Royal Medal in 1929 and the Sylvester Medal in 1943. In making the latter award, the President of the Royal Society said: "He was the man most likely to storm and smash a really deep and formidable problem: there was no one else who could command such a combination of insight, technique and power".

Mathematics at Cambridge: Mr. A. S. Besicovitch, F.R.S.

Mr. A. S. Besicovitch, who succeeds Prof. Littlewood, began research in Russia under the famous Markoff. He left Russia in 1925, and with a Rockefeller studentship worked in Copenhagen and Oxford for two years. After a year as lecturer at the University of Liverpool, he was appointed to a lectureship at Cambridge; he has been a fellow and lecturer of Trinity College since 1930. He was elected to the Royal Society in 1934. Besicovitch is a 'real variable analyst'. His work is normally as austere as it is distinguished, and by temperament he avoids the limelight, but dramatic surprises pursue him. He has recently exploded a long-accepted theory of the area of a surface. This is a highly technical matter; but two other surprises are intelligible to the layman. In 1927 there was the following unsolved problem: Find a figure of least area within which a segment of unit length can turn through 360° in continuous movement. Everyone accepted the common-sense solution of a 3-cusped hypocycloid of area $\frac{1}{2}\pi$. Besicovitch's solution, however, is that the figure can have arbitrarily small area ε; it grows infinitely complicated as $\varepsilon \to 0$ and spreads towards infinity in all directions (*Math. Z.*, **27**, 312). The second example is actually a re-discovery (*J. London Math. Soc.*, **22**, 285) of a forgotten result by Tietze of 1905; but it is a perfect foil to the first: What is the maximum number of convex polyhedra, non-overlapping, and any pair having contact over a positive area? (The corresponding number in two dimensions is 4.) Having annihilated an area the first time, Besicovitch has now done the opposite; for this answer is infinity.

T. G. Masaryk (1850–1937)

March 7 is the centenary of the birth of Thomas Garrigue Masaryk. Born of humble parents at Hodonin in Moravia, he served as an apprentice first to a Vienna locksmith and then to a country blacksmith before a local schoolmaster arranged for his entry into the secondary school at Brno, the Moravian capital, in 1865. In 1872 he matriculated at the University of Vienna and studied philosophy, graduating as Ph.D. in 1876. After an anxious period as a lecturer in Vienna, Masaryk was appointed professor of philosophy at Prague when the University was re-organised in 1882. From that time until 1914 Masaryk wrote and lectured on philosophical subjects with the object of promoting Czech culture, especially as regards modern trends. He founded the daily *Čas* ('The Times') and himself conducted its weekly science column. From time to time he became involved in philosophical disputes and in political controversies and was thrice elected to the Austrian parliament. In 1918 he was elected first president of the Czecho-slovak Republic, and with Beneš, his son Jan Masaryk, and others, achieved a good measure of success, especially in culture and technology, in both of which Masaryk himself was keenly interested. The University of Brno, founded in 1919, bears his name, and so does the Masaryk Academy of Work, which sponsored many scientific and engineering projects. It seemed as if Czech science and learning, with sound traditions rooted in the past, was at last attaining the success it deserved, when the State was first dismembered and then occupied by the Germans in 1939. Masaryk's spirit, his insistence upon the force of the Hussite motto, "Truth Prevails", and his influence still remain to inspire the nation afresh in its struggles against adversity.

Geological Society: Foreign Members

The following have been elected foreign members of the Geological Society: Prof. J. Cadisch, professor of geology, University of Berne; Prof. C. O. Dunbar, professor of palæontology and stratigraphy, Yale University; Prof. R. F. Flint, professor of geology, Yale University; Dr. P. A. Geijer, director of the Geological Survey of Sweden; Prof. M. Gignoux, professor of geology and mineralogy, University of Grenoble; Prof. L. C. Graton, professor of geology, Harvard University; Prof. A. Heintz, professor of palæontology, University of Oslo; Prof. R. Richter, professor of geology and palæontology, University of Frankfurt; Prof. A. S. Romer, professor of zoology, Harvard University; Prof. L. Störmer, professor at the Palæontological Institute, Oslo; Prof. T. Vogt, rector of the Norges Tekniske Högskole, Trondheim.

Journal of the Optical Society of America

Beginning with the January 1950 issue, Dr. Wallace R. Brode, associate director of the United States National Bureau of Standards, succeeds Prof. G. R. Harrison as editor of the *Journal of the Optical Society of America*. Dr. Brode has been for several years a director of the Society and an associate editor of the *Journal*. In an editorial to the December 1949 issue of the *Journal* (**39**, 979), Prof. Harrison pays tribute to his successor and remarks on the rapid growth, both in size and numbers printed, of the *Journal* during the past decade. The number of subscribers, now 3,700, has almost trebled; and the increase in size of the *Journal* is illustrated by the fact that when Prof. Harrison took over the editorship ten years ago it was his ambition to average sixty-four pages per issue; but now his successor will have to tackle the pressing problem of the limitation of each issue to the ninety-six much larger pages allowed for in the 1950 budget of the Society.

Science for Farmers

Criticisms have recently been made that little progress is being made in the teaching of science in adult education classes despite a widespread interest in current science among members of the general public. These criticisms are well founded, and it is

refreshing to read of places where attempts are being made to show how science can be taught to adults in the local community. The luncheon room of the Fox Inn in Worcestershire is such a place, and here, under the auspices of the Extra-Mural Department of the University of Birmingham, Gilbert Cope has recently completed a series of lectures on biological topics to a representative cross-section of the local male population (*Further Education*, **3**, No. 2; September–November 1949). Since the lectures were held at the normal place of evening congregation little could be attempted in the way of demonstration, but the use of topical films added to the interest of the course. To arouse enthusiasm, this course had been preceded by a trial run of four lectures on soils and plant physiology which had been succeeded by another course on more practical aspects of farming like breeding and rearing, feeding, milking, calf rearing, and management of young stock. The real value of further education of this kind is that it brings the results of scientific research to the people who can effectively employ them, and so unites academic achievement with practical labour.

Weekly Records of Earthquake Epicentres

THE epicentre cards sent out by the United States Coast and Geodetic Survey, Washington, D.C., and prepared by the Survey in co-operation with Science Service and the Jesuit Seismological Association, have long been a boon to seismological observatories. These observatories are now more deeply indebted to the Survey, under its director, Rear-Admiral L. O. Colbert, for a new series of weekly cards, the first of which was issued on June 30, 1949, giving a tabulation of minor earthquakes. The range of epicentres is world-wide, and for each earthquake the initial time is given together with the preliminary determination of epicentre (latitude and longitude) if observations warrant this—otherwise the epicentral area is named. The first earthquake mentioned occurred on June 12, and the weekly numbers listed have been 7, 5, 8, 7, 21, 9, 8, 11, 5, 27, 7 and 7 so far. Although the new lists are probably not entirely comprehensive, chiefly owing to lack of a complete world-wide network of observatories and also difficulties of communication, they do give an idea of the seismic activity in the world when coupled with the details of major earthquakes on the epicentre cards (old series) which have been issued by the same office for so long.

Blundell's School Science Society

Two articles in the magazine of Blundell's School Science Society show the high standard of work which can be obtained from schoolboys who are encouraged to do original work. In one, O. F. Amor describes some observations made on the effect of acidity on the distribution of *Gammarus pulex* in a moorland stream. Although the investigations could not be conducted on a scale to justify firm conclusions, the evidence obtained indicates that *G. pulex* does not tolerate a *p*H lower than 6·5. It is probable that this freshwater shrimp cannot exist long in water of this acidity, but that a neutral or slightly alkaline medium of *p*H 7–7·5 is favourable. In the other article, D. C. R. Stephens discusses the competition between weeds and grasses from investigations made in various school lawns. His observations confirm the theoretical requirements for a successful weed in a lawn, namely, rapid germination, growth and development, rapid reproduction and effective means of evading the mower. The magazine also contains an account of a study of the blue-tit as well as records made by the ornithological, meteorological and other sections.

Frank B. Jewett Fellowships: New Awards

THE American Telephone and Telegraph Co. has awarded Frank B. Jewett fellowships to the following: Dr. J. B. French, a graduate in physics and mathematics of Dalhousie University, Nova Scotia, and the Massachusetts Institute of Technology, for research at the Institute for Advanced Study, Princeton, on higher-order radiative processes in the quantum theory of fields; Dr. Ilse L. Novak, a graduate in mathematics of Hunter College and Radcliffe College, for research at the University of California on relation algebras; Mr. R. F. Steiner, a graduate in chemistry of Princeton University and at present a graduate student at Harvard University, for research at the University of California on light scattering of the actin-myosin system, and its relation to the phenomena of muscular contraction; Dr. D. E. Mann, a graduate in chemistry and physics of the City College of New York and the University of Chicago, for research in quantum mechanics at Harvard University (Dr. Mann held a Jewett fellowship last year); Dr. Roy J. Glauber, a graduate in physics of Harvard University and at present an Atomic Energy Commission postdoctorate fellow at the Institute for Advanced Study, Princeton, for research at the Institute on the theory of elementary particles. Grants for the fellowships were established in 1944 by the American Telephone and Telegraph Co. upon the retirement of the late Dr. Jewett as vice-president in charge of development and research, and since that time thirty-three awards have been made. The fellowships are designed to stimulate and assist research in the fundamental physical sciences by men of science who have recently received or are due to receive doctorates. The awards are made on the recommendation of a committee of seven from the Bell Telephone Laboratories; they carry a grant of 3,000 dollars to the recipient and 1,500 dollars to the institution at which the research is done.

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have been recently announced: E. Bellis (agricultural officer, Kenya), soil chemist, Kenya; C. W. S. Hartley (agricultural officer, Federation of Malaya), senior agricultural officer (research), Federation of Malaya; M. Greenwood (principal agricultural officer, Nigeria), assistant director of agriculture (experiments), Nigeria; H. J. S. Simpson (agricultural officer, Federation of Malaya), senior agricultural officer, Federation of Malaya; O. J. Voelcker (director, West African Cocoa Research Institute, Gold Coast), director of agriculture, Federation of Malaya; J. West (principal research officer, West African Cocoa Research Institute, Gold Coast), director, West African Cocoa Research Institute, Gold Coast; L. G. T. Wigg (senior assistant conservator of forests, Tanganyika), deputy conservator of forests, Tanganyika; G. M. Stockley (chief geologist, Tanganyika), director of geological survey, Tanganyika; J. G. Black (veterinary surgeon, British Guiana), veterinary officer, Northern Rhodesia; D. Sheriff (veterinary officer, Northern Rhodesia), veterinary officer, Kenya; W. Uruski (veterinary officer, British Guiana), senior veterinary officer,

British Guiana; A. E. Billington, canning officer, Federation of Malaya; J. Duncan, agricultural officer, Kenya; G. C. Gamey, agricultural officer, Nigeria; J. D. A. Harris, agricultural officer, Sierra Leone; C. B. Mead, agricultural officer, British Solomon Islands Protectorate; R. M. Scott, soil survey officer, Agricultural Department, Gold Coast; R. G. Tapley, entomologist, Tanganyika; M. S. Foulstone and C. A. N. Nash, assistant conservators of forests, Nigeria; L. R. Allen, geologist, Federation of Malaya; K. G. Gadd, pathologist, Northern Rhodesia; J. F. F. Callear, veterinary officer, British Guiana; M. B. Proverbs, veterinary officer, Barbados; P. W. Thorold and M. L. Burdin, veterinary research officers, Kenya; S. C. Abel and T. A. Dillon, agricultural survey officers, Gold Coast; K. H. Bain, fisheries officer, Gold Coast; A. D. H. Berwick, biologist, Game and Tsetse Control Department, Northern Rhodesia; C. R. Harler, tea research officer, Nyasaland; H. R. Mapother, insecticide chemist, West African Cocoa Research Institute, Gold Coast; R. G. Mares, veterinary officer, Somaliland Protectorate; D. Small, assistant conservator of forests, Sierra Leone; D. R. Wilson, statistician, Statistical Department, East African High Commission; L. F. U. Wix, government chemist, Medical Department, Gold Coast.

University of London: Appointments

THE following appointments in the University of London have been announced: Dr. J. E. Smith, lecturer in zoology in the University of Cambridge, to the University chair of zoology tenable at Queen Mary College from October 1, 1950; Dr. D. D. Reid to the University readership in epidemiology and vital statistics tenable at the London School of Hygiene and Tropical Medicine from January 1, 1950.

The title of professor of agricultural chemistry in the University has been conferred on Dr. R. L. Wain in respect of the post held by him at Wye College; and that of reader in bacteriology in the University on Dr. S. E. Jacobs in respect of the post held by him at the Imperial College of Science and Technology.

The title of emeritus professor in the University has been conferred on the following: Prof. E. N. da C. Andrade, Quain professor of physics at University College during 1928–49; Prof. C. S. Gibson, professor of chemistry at Guy's Hospital Medical School since 1921; Prof. Hamilton Hartridge, professor of physiology at St. Bartholomew's Hospital Medical College during 1927–47; and Sir Ian Heilbron, professor of organic chemistry at the Imperial College of Science and Technology during 1938–49.

The following doctorates have been conferred: *D.Sc.*: Mr. H. H. Hatt (external student); Mr. G. E. Turfitt (external student); *D.Sc.* (*Eng.*): Prof. C. A. Hart (University College).

International Exhibition of Wild Life Photography

THE second International Exhibition of Wild Life Photography, organised by *Country Life*, will be held at the Central Hall, Westminster, London, during March 20–April 1, excluding Sunday. More than four thousand entries have been received from sixteen countries as well as from British photographers. Of these, about 1,400 subjects have been chosen for exhibition by the Selection Committee. These photographs are divided into sections of mammals, birds, insects, fish and amphibians. In addition, there is a section devoted to colour transparencies. An important addition to the Exhibition will be lectures illustrated by films or slides twice daily. The Nature films will undoubtedly be the finest ever shown at one exhibition and the majority are in colour. The Exhibition will be opened by Field-Marshal Viscount Alanbrooke on the afternoon of March 20.

International Congress of Mathematicians

THE first international Mathematical Congress to be held since 1936 will take place at Cambridge, Massachusetts, during August 30–September 6, under the sponsorship of the American Mathematical Society. A grant of ten thousand dollars has been made by the United Nations Educational, Scientific and Cultural Organisation to be used for travelling expenses of foreign mathematicians attending the Congress. A conference, which it is hoped will lead to the formation of an International Mathematical Union, will be held just before the Congress, and for this Unesco has made a similar additional grant of ten thousand dollars.

Announcements

PROF. R. A. PETERS, Whitley professor of biochemistry in the University of Oxford, has been awarded the Cameron Prize in practical therapeutics for 1950, given by the University of Edinburgh, in recognition of his discovery of British anti-lewisite (B.A.L.) and the application of this drug in practical therapeutics.

A RAMSAY Memorial fellowship is being offered for chemical research. The fellowship is worth £400 a year, with a grant for research expenses not exceeding £100 per annum, and is normally tenable for two years. Further particulars can be obtained from the Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1, to whom applications must be forwarded not later than April 17.

THE Chemical-Biological Coordination Center of the National Research Council will hold a two-day symposium on chemical-biological correlation in Washington, D.C., during May 26–27. The meeting will include papers on the relation of the structure of compounds to their biological activities, discussions, and a session illustrating the operations of the Center and the services it can provide to scientific workers. It is expected that a symposium volume will be prepared and published after the meeting. Those interested in attending should register as soon as possible with the Symposium Committee, Chemical-Biological Coordination Center, National Research Council, 2101 Constitution Ave., N.W. Washington 25, D.C.

UNDER the terms of a reciprocal arrangement with the Centre National de la Recherche Scientifique, the Medical Research Council is offering two scholarships in medical science, excluding clinical medicine, which are tenable at research institutions in France during the academic year 1950–51. Candidates must be of British nationality and have at least a working knowledge of French. The scholarships are worth 30,000–60,000 francs a month, according to qualifications and experience, plus travelling expenses and a supplementary marriage allowance. Application forms can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1, and must be returned by March 31.

ISOLATION OF A CRYSTALLINE TOXIC FACTOR FROM AGENIZED WHEAT FLOUR

By Dr. P. N. CAMPBELL, Dr. T. S. WORK and
Sir EDWARD MELLANBY, G.B.E., K.C.B., F.R.S.

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IN 1946 it was established by Mellanby[1] that dogs fed a diet rich in commercially 'improved' (nitrogen trichloride-treated) flour were subject to epileptiform fits; similar fits were never seen in control animals fed on untreated flour. Mellanby concluded that the treatment of flour with nitrogen trichloride gave rise to a toxic factor which was responsible for the condition in dogs well known in Great Britain as 'canine hysteria' and in the United States as 'running fits'.

A large proportion of the flour milled in Britain and used for bread-making is 'improved' by treatment with nitrogen trichloride and is known commercially as 'agenized' flour. The observation that this flour was toxic to dogs was followed by a demonstration that it was also toxic to ferrets[2], to cats[3], and to rabbits[4]. It thus became a matter of some importance to discover the nature of the toxic factor and to assess the possible danger which might arise from the use of agenized flour.

Method of Test

Throughout the present investigation the criterion of toxicity adopted has been the production of a typical epileptiform fit in the ferret. The ferret is slightly less sensitive than the dog on a body-weight basis; but the small size of the animal enabled us to obtain a toxic reaction with a much smaller dose of agenized flour than would be necessary for a dog.

The demonstration by Mellanby[2] that toxicity was confined to the gluten fraction of the flour suggested that the toxic factor might be a modified amino-acid or peptide. The final method of isolation which is outlined below was based on this assumption.

Isolation of Crystalline Toxic Factor

Flour was agenized by the standard procedure but with ten times the amount of nitrogen trichloride used in commercial practice (11·1 gm. NCl_3 to 17·7 kgm. flour). This flour was toxic to a ferret in a dose of 100 gm. (1·9 gm. nitrogen) fed over three days. Gluten was separated from the flour and digested first with pepsin and then with trypsin. The digest was dialysed and the dialysate hydrolysed for four hours with strong hydrochloric acid. The acid was removed and the hydrolysate electrodialysed. The neutral fraction from the electrodialysis was treated with sufficient charcoal to remove the aromatic amino-acids[5], and the residual neutral amino-acid mixture was then fractionated on a 'Zeokarb 215' column by the method of Partridge[6]. A fraction was obtained from the 'Zeokarb' column which produced a typical fit in a ferret when fed for three days at a level of 17 mgm. nitrogen per day. This active material contained at least fifteen components and was further fractionated by chromatography on a paper column ('Solka Floc') using a mixture of butanol, acetic acid and water as solvent. The toxic factor crystallized when the appropriate fraction of the effluent was concentrated.

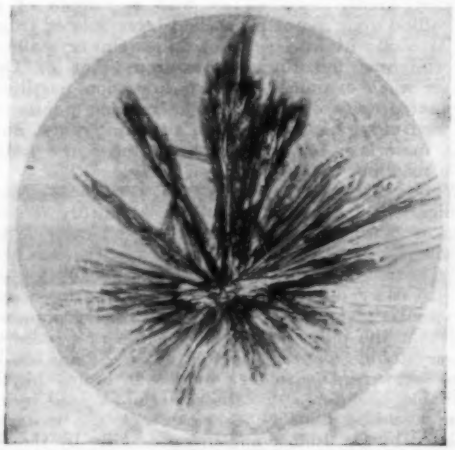
Toxicity

The crystalline toxic factor (see accompanying illustration) produced severe epileptiform fits in a ferret when fed for five days at a level of 100 μgm. nitrogen per day; this represents a total dose of crystalline material of approximately 3 mgm. The pure toxic factor is thus 33,000 times as toxic as the original flour.

When fed as a single dose the crystalline material is slightly more toxic than when the dose is spread over several days. A single dose of 2 mgm. is sufficient to produce typical epileptiform fits in a ferret, and a slightly greater dose kills the animal. Particular emphasis must be laid, however, on the cumulative nature of the poisonous effect. We have demonstrated in the ferret that a fatal toxic reaction can be produced by feeding the concentrated toxic factor in small doses over a period of five to ten days, and that the daily intake in such cases is only a fraction of the dose required to produce an immediate toxic response. It must be added, however, that this toxic action is not a simple problem and is probably influenced by other elements in the diet.

Nature of the Toxic Factor

As the amount of toxic factor in flour is small (1 gm. per 33,000 gm. flour) and the isolation procedure gives an overall yield of only 10 per cent, the greatest difficulty has been experienced in obtaining sufficient material for combined biological



Crystalline toxic factor from agenized flour (× 180, phase contrast)

and chemical characterization. All the results reported below have been obtained on about 10 mgm. of crystalline toxic factor.

We were initially of the opinion that the toxic factor was a peptide, since a sample hydrolysed for twenty-four hours with 6*N* HCl at 110° and examined by partition chromatography[7] in two dimensions on paper was found to give six ninhydrin-positive spots. One of these spots was, however, identified as the toxic factor itself, and even forty-eight hours hydrolysis did not destroy it entirely. As a peptide could scarcely be expected to resist such vigorous hydrolytic conditions some doubt arose in our minds as to the peptide nature of our material.

A specimen of toxic factor hydrolysed for 24 hr. with 6*N* hydrochloric acid was studied in detail and the following degradation products were provisionally identified by paper chromatography: homocysteic acid, α-aminobutyric acid, methionine sulphoxide, methionine sulphone and homoserine. Since all these compounds can be regarded as possible degradation products of a molecule containing the methionine skeleton, we concluded that our toxic factor was probably derived from methionine. A small sample of the crystalline material was desulphurized by treatment with Raney nickel[8], and the product identified by paper chromatography as α-aminobutyric acid; methionine gave α-aminobutyric acid under similar conditions.

It might be thought from the above evidence that the toxic factor was produced from methionine by a simple reaction with nitrogen trichloride. However, this would not appear to be so, for Silver[9] has shown that when methionine is treated with nitrogen trichloride the toxic factor is not produced. We have recently treated the following peptides (kindly supplied by Dr. Fruton) with nitrogen trichloride: methionyl-glycine, carbobenzoxymethionyl-methionine amide and carbobenzoxymethionyl-methionine, and were unable to detect the presence of the toxic factor by partition chromatography after either a 4- or 16-hr. hydrolysis with strong hydrochloric acid at 110° C.

Comparison of Toxic Factors from Wheat Flour and Zein

Dr. Reiner, of Wallace Tiernan and Co., has recently kindly supplied us with a sample of a crystalline toxic factor which had been isolated from zein treated with nitrogen trichloride. Our crystalline material was indistinguishable from that of Dr. Reiner when examined by two-dimension partition chromatography on paper. The melting points of the two materials were within the same range, and both materials, fed to ferrets, produced the same toxic reaction.

While this work was in progress three communications[10] appeared from the laboratory of the British Flour-Millers Research Association, St. Albans, on a toxic factor present in nitrogen trichloride-treated zein. Although we have not been able to carry out a direct comparison between our own material and that isolated by this group, we find that the published details on the properties of the crystalline material isolated at St. Albans are in close agreement with our own. It seems highly probable, therefore, that the material isolated by us from agenized flour is identical with the material isolated by Dr. Reiner and independently by the St. Albans group from nitrogen trichloride-treated zein.

We are indebted to Mr. J. Smiles for the photograph of the crystalline toxic factor and to Dr. C. Dent for samples of homoserine and α-aminobutyric acid.

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DIRECT OPTICAL MEASUREMENT OF THE LENGTH OF ORGANIC MOLECULES

By Dr. J. S. COURTNEY-PRATT

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STUDIES are being made in this Laboratory of the nature and structure of the surfaces of solids and of films adsorbed on them. Adaptation of the optical techniques developed by Tolansky[1-6] makes it possible to examine detail with a resolution approaching 1 Angström. Direct measurements have now been made of the thickness of monomolecular layers of adsorbed organic materials.

If a collimated beam of monochromatic light of wave-length λ falls on a pair of partially reflecting surfaces separated by a small thickness t of material of refraction index μ, interference fringes will in general be visible either in reflexion or transmission. Maxima of intensity in transmission, that is, for Fizeau fringes, will occur where $2\mu t \cos\varphi = n\lambda$; n is an integer, φ is the angular departure from normal incidence measured in the medium between the surfaces. For low coefficients of reflexion, the variation of intensity from one fringe to the next follows approximately a cosine[2] curve. For high coefficients of reflexion the variation of intensity follows closely the Airy distribution[7]. Tolansky has shown that the width of these sharpened Fizeau fringes can be twenty times less than for two-beam interference. That is, the width of the fringes at half their maximum intensity can be as small as 2 or 3 per cent of the spacing of the fringes, and also the maximum rate of change of intensity with change of thickness can be ten or twenty times greater than for two-beam interference, provided that the physical conditions are made suitable. In particular, the reflexion coefficient must be made high—preferably greater than 90 per cent, and the absorption kept low so that there is a significant transmission coefficient. It is critical that the spacing t should be kept small. The incident light should be carefully collimated; and the wedge angle between the surfaces should be small.

To attain optimum resolution and to satisfy these and other minor experimental conditions, a thin piece of muscovite mica was chosen as a reference material. For such a material, where the upper and lower reflecting surfaces are almost exactly parallel, the

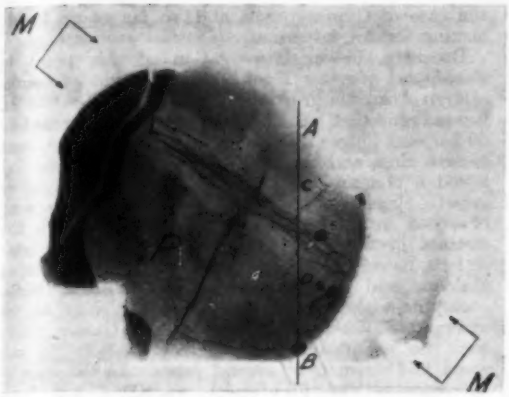

Fig. 1. Photograph, at 3 ×, of a piece of mica showing clearly the region *MM* on which a monomolecular layer of stearic acid had been spread. After adding the monomolecular layer, both sides of the specimen were silvered. Illumination was provided by a collimated beam of monochromatic light of wave-length 5461 A. The specimen was tilted 4° from normal incidence, so that the transmitted intensity for facet *P* was approximately half the maximum. Small sustained changes in thickness were then evident as considerable changes in intensity. The fine scratches within the area *MM* were made while spreading the stearic acid. The ghost fringes most visible at the top right are due to reflexions from the microscope slide supporting the specimen

spacing between successive fringes is indefinitely large. Any facet of constant optical thickness will transmit a monochromatic radiation with uniform intensity[4–6]. If the wave-length is so chosen with respect to the average optical thickness and the angle φ that the transmitted intensity is half the maximum, then minute changes of thickness will be evident as considerable changes of transmitted intensity. With typical values of reflexion coefficients attained in practice, a change in thickness of 10 A. can produce a change of intensity of between 15 and 25 per cent.

Fig. 1 is a photograph of a piece of muscovite mica at three times natural size. The facet *P* is of uniform thickness to a single lattice spacing over its whole extent. On part of one side of this facet a monomolecular layer of stearic acid ($C_{17}H_{35}COOH$) has been spread by a modification of the droplet-retraction technique. Silver has then been evaporated *in vacuo* on to both sides of the specimen until the reflexion coefficients are greater than 90 per cent. A collimated beam of monochromatic light from a low-pressure mercury-arc lamp was used to illuminate the specimen, which was then tilted 4° from the normal so that the transmitted intensity for facet *P* was approximately half the maximum obtainable. The region *MM* over which the monomolecular layer had been spread is plainly visible in the photograph.

The uniformity and extent of an adsorbed monomolecular layer can be examined qualitatively as described above. An unambiguous quantitative measure of thickness can be made using the same specimen. Illuminate it at normal incidence with a collimated beam of white light, and use the transmitted light to form an image of the specimen at the plane of the slit of a spectrograph. It is now possible to determine what wave-lengths are most strongly transmitted for all points of the image that fall on the spectrograph slit; that is, for all points on any chosen line section of the specimen.

The interference fringes that appear at the plate of the spectrograph have been called fringes of equal chromatic order[3,4]. The wave-lengths of maximum intensity satisfy the same equation as before, $2\mu t \cos\varphi = n\lambda$; and also the variation of intensity from one fringe to the next again follows the Airy distribution. Maximum fringe sharpening depends in almost the same way on the experimental variants.

Fig. 2 shows the fringes of equal chromatic order for the line section *AB* of Fig. 1. The fringes are all doublets because of the birefringence of mica. The displacement $\delta\lambda$ of the section *CD* corresponding to the region over which the monomolecular layer of stearic acid had been spread is $2{\cdot}0 \pm 0{\cdot}3$ A., so that the measured thickness of the monomolecular layer is $n\delta\lambda/2\mu = 19 \pm 3$ A. From X-ray studies, the length of the *c*-axis of stearic acid in crystalline form is 48·84 A. The unit cell is formed of two molecules attached by their acid end-groups. Electron diffraction studies indicate that on reactive or on noble metals, fatty acid molecules in the first adsorbed layer are arranged with the acid end-groups adjacent to the solid surface and with the hydrocarbon chains standing at right angles to the surface. If the molecules are similarly oriented when adsorbed on mica, the expected thickness of the monomolecular layer would be half the length of the *c*-axis, that is, 24·42 A.

Fig. 3*a* is a photograph of the fringes of equal chromatic order for a different specimen of mica showing two facets, *Q* and *R*. Fig. 3*b* is similarly a line section across the same specimen but crossing a region of facet *Q* on which had been spread a monomolecular layer of octacosanoic acid ($C_{27}H_{55}COOH$). The measured thickness of the monomolecular layer is $30 \pm 1\frac{1}{2}$ A. The value of half the length of the *c*-axis from X-ray data is 37·02 A.

The discrepancy between the measured values and those obtained by X-ray methods is not a random experimental error, but is most probably due to the differences in the phase change on reflexion at the mica – silver surfaces and the monolayer – silver surfaces and possibly also on transmission at the monolayer – mica surfaces. These phase changes would be indistinguishable from real thickness effects. For adsorbed layers of both stearic acid and octacosanoic acid the phase changes at the monolayer – silver interfaces should be equal, as the inert end-groups of the straight-chain molecules are identical; and similarly any phase changes at the monolayer – mica surfaces for both these acids should be equal as they adsorb to the mica by similar acid end-groups. This hypothesis is confirmed, within the limits of experimental measurement, as the difference in the measured lengths of the fatty acid molecules (30 A. − 19 A. = 11 A.) is closely the same as the difference obtained from X-ray observations (37·02 A. − 24·42 A. = 12·6 A.).

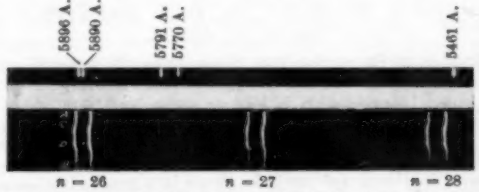

Fig. 2. Fringes of equal chromatic order for the line section *AB* of Fig. 1. The wave-length of the line *AB* is 5899 A. The displacement to *CD* is $2{\cdot}0 \pm 0{\cdot}3$ A., so that the measured thickness of the monomolecular layer of stearic acid is $n\delta\lambda/2\mu = 19 \pm 3$ A. The dispersion near the *D* lines is 3·5 A./mm. The magnification of lateral dimensions in the direction parallel to the slit is 2 ×. Displacements in wave-length are linearly related to changes in thickness of the specimen, so that in this photograph the magnification in height and depth is 315,000 ×. (Reproduced two-fifths original size)

Fig. 3. Fringes of equal chromatic order for two facets Q and R of a specimen of mica
(a) Fringes for a line section across the facets where no monomolecular layer had been spread
(b) Fringes showing a displacement of $7{\cdot}4 \pm 0{\cdot}3$ A. on that part of facet Q on which a monomolecular layer of octacosanoic acid had been spread. The measured thickness of this layer is then $n\delta\lambda/2\mu = 30 \pm 1\frac{1}{2}$ A. The dispersion near the D lines is 3·5 A./mm.
The magnification of lateral dimensions is 2·3 ×; the magnification in height and depth is 720,000 ×. (Reproduced two-fifths original size)

By traversing the specimens across the line of the spectrograph slit, it has been possible to examine methodically the whole of the areas over which the organic materials had been spread. Near the lateral boundary of a layer there is a decrease in its apparent thickness. Away from the boundary the layer is uniform. Polymolecular layers are absent. The method therefore provides direct and independent evidence that the molecules of fatty acids spread by the retraction technique are adsorbed on the surface as a uniform monomolecular layer.

I wish to express my thanks to Dr. F. P. Bowden for his encouragement and advice, to Imperial Chemical Industries, Ltd., for the provision of the spectrograph, to the Ministry of Supply (Air) for support and to the Royal Commissioners for the Exhibition of 1851 for the award of a Senior Studentship.

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CHANGES IN FIBRE-LENGTH WITHIN ONE GROWTH RING OF CERTAIN ANGIOSPERMS

By I. J. W. BISSET, Dr. H. E. DADSWELL and G. L. AMOS

Division of Forest Products, Commonwealth Scientific and Industrial Research Organisation, Melbourne

THE general pattern of variation in tracheid and fibre dimensions within a tree is well known. Sanio[1], many years ago, established that at a fixed level in *Pinus sylvestris* L. there is a gradual increase in mean tracheid length from the initial ring outwards until a more or less constant length has been reached, and, further, that there is a variation with height in the tree. Other workers[2] have confirmed these findings with various species of Gymnosperms and Angiosperms. However, evidence regarding the variation within one growth ring is contradictory in the case of Gymnosperms and, so far as we know, lacking for Angiosperms.

Recently, in an investigation of this point in *Eucalyptus gigantea* Hook. f., a eucalypt of south-eastern Australia growing at altitudes of 3–4,000 ft., it was found that late wood fibres were approximately 60 per cent longer than early wood fibres of the same growth ring, and that the fibre-length variation followed a characteristic pattern through the various growth rings (see Fig. 1). Similar variations were observed in other eucalypts which also have the distinct growth rings indicative of temperate conditions, namely, *E. regnans* F. v. M., *E. dalrympleana* Maiden, and *E. pauciflora* Sieb.; but in those eucalypts without such definite growth rings, as, for example, *E. deglupta* Blume from New Guinea, there were no significant fibre-length variations in the wood laid down over several years. In the case of *E. gigantea* the fibre-length variation has been directly correlated with growth-rate[3]. It has been shown that the shortest fibres from the first-formed early wood of a growth ring are coincident with the maximum growth of early spring, and the longest fibres from the last-formed late wood with the minimum growth of early winter; the increased fibre-length of the late wood is accommodated by a greater overlap of the fibres.

Following these observations, a preliminary survey has been made of fibre-length variation within one growth zone of various Angiosperm timbers. Results obtained are given in the accompanying table. In those species with definite growth rings, the late wood fibres were considerably longer than the early wood fibres and, in some of the ring-porous species, they were two to three times as long. Generally, the fibre-length pattern within the growth ring followed that shown for *E. gigantea* (Fig. 1); but in certain species the increase in length was rapid, and a more or less constant value was quickly reached (for example, *Tectona grandis* Linn. f., see Fig. 2). Chalk and Chattaway[4] have reported that the vessel members of the early wood of ring-porous woods are consistently of greater diameter and shorter than the vessel members of the late wood. This is in agreement with our observations on fibres, and supports the conclusion that there must be a close relationship between cell dimensions and growing conditions, because growth in such species is at a maximum in the early part of the growing season. The species from tropical regions showing indistinct growth zones showed little variation in fibre-length in the wood laid down during several years growth.

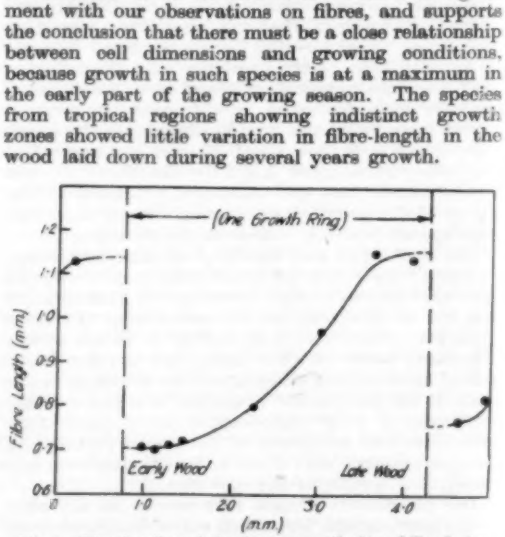

Fig. 1. Fibre-length variation in one growth ring of *Eucalyptus gigantea* Hook. f.

FIBRE-LENGTH VARIATIONS BETWEEN EARLY WOOD AND LATE WOOD OF THE ONE GROWTH RING IN SELECTED ANGIOSPERMS

Species	Mean fibre-length of First formed early wood (mm.)	Mean fibre-length of Last formed late wood (mm.)	Percentage difference based on early wood length
A. Eucalypts with distinct growth rings			
E. gigantea Hook. f.	0·71	1·15	62
E. regnans F. v. M.	0·81	1·19	47
E. dalrympleana Maiden	0·97	1·28	32
E. pauciflora Sieb.	0·70	1·00	43
B. Ring-porous timbers and diffuse porous timbers with distinct growth rings			
Castanea sativa Mill.	0·62	1·35	118
Quercus robur L.	0·71	1·33	87
Fraxinus excelsior L.	0·51	1·46	186
Ulmus campestris L.	0·72	1·54	114
Cedrela toona Roxb. var. *australis* C.DC.	0·75	1·37	83
Tectona grandis Linn. f.	0·93	1·34	44
Fagus sylvatica L.	1·18	1·44	22
Populus tremuloides Michx.	0·83	1·28	54
C. Species without distinct growth rings			
Castanea javanica Blume*	1·17	1·27	8·5
E. deglupta Blume *E. grandis* (Hill.) Maiden *Lithocarpus perciua* Mgf.	No significant variation over several growth zones		

* Some indication of growth rings

In view of the results obtained, it is appropriate to discuss briefly the variation of tracheid-length within one growth ring of various Gymnosperms. Gerry[5] reported that in *Pseudotsuga taxifolia* (Lamb.) Britt. the late wood tracheids were shorter than those of the early wood. Lee and Smith[6], working with the same species, obtained contrary results; their observations are supported by those of Kribs[7] (with *Pinus banksiana* Lam.) and Chalk[8] (with *Picea sitchensis* (Bong.) Carr.), both of whom state that the tracheids of the late wood are slightly longer (12 per cent in *P. sitchensis*) than those of the early wood. Recently, Wardrop[9] referred to the decrease in the tracheid-length of *Pinus radiata* D. Don from the early wood to the late wood of the one growth ring. We have examined a number of Gymnosperms, including those mentioned above, and have found that, in all cases where compression wood is not present, the late wood tracheids are slightly longer (up to 11 per cent) than the early wood tracheids, thus confirming the observations of Kribs and Chalk. It would seem, therefore, that the variation within a growth ring follows the same general trend in both Angiosperms and Gymnosperms in which distinct growth rings are present, although the variation in length from early wood to late wood is much less marked in the Gymnosperms.

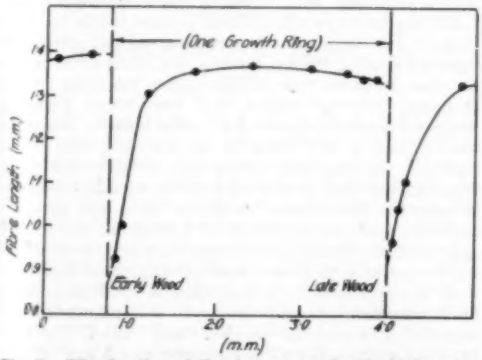

Fig. 2. Fibre-length variation in one growth ring of *Tectona grandis* Linn. f.

In all the investigations reported here, fibres (or tracheids) were obtained by the maceration of serial tangential sections (80 or 120 μ thick) cut through one or more growth rings of the timber under examination. Fifty fibres from each section were selected at random for measurement. The differences in mean fibre-length as given in the table have been shown by statistical analysis to be highly significant.

This work, which will be reported in detail elsewhere, forms part of the programme of the Division of Forest Products, Commonwealth Scientific and Industrial Research Organisation, Australia.

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NATIONAL RESEARCH COUNCIL OF CANADA

ANNUAL REPORT

THE thirty-second annual report of the National Research Council of Canada* contains the report of the president, Dr. C. J. Mackenzie, and the financial statement for the year ended March 31, 1949, and provides a general conspectus of the work which is now described in fuller detail in the "National Research Council Review". Progress with atomic energy has continued, and the Isotope Branch has distributed thirty-four different isotopes to twenty-one institutions for experimental work in pure and applied science. The Chemical Engineering Research Branch has been enlarged to investigate new plant-processes for separating and purifying the products, and the Technical Physics Branch has notably improved the design and reliability of electronic engineering devices and microchemical equipment. In the Division of Applied Biology some further fundamental work was undertaken in the study of the fermentative breakdown of cellulose, the installation of electrophoresis and diffusion-rate equipment for the study of proteins and carbohydrates, studies on halophilic bacteria, and the physiology of muscle in rigor. Work on the Fritz continuous butter-making machine continued, as well as pilot-plant investigations on the fermentation of beet molasses and the processing of gluten from wheat flour.

The Division of Building Research, which started work during the year, has concentrated its attention on questions of building practice in relation to house construction. In the Pure Chemistry Branch photo-

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chemical and other kinetic investigations have been made on ether, acetone, acetaldehyde, ethylene oxide and a number of hydrocarbons. Radioactive carbon is being used for labelling particular functional groups to follow their course in photochemical reactions. The compressibility of pure helium in the temperature range 0–600° C. has been determined with a high degree of accuracy. Work has continued on the infra-red spectra of complex organic compounds, especially those of biological importance, and on plant alkaloids, particularly on the chemical constitution of those alkaloids previously discovered in the laboratory; the investigation of the acid-dyeing of wool has also continued.

Besides its advisory functions to other government departments on the supply or testing of chemicals, the Applied Chemistry Branch is investigating the use of the fluidized bed technique for the recovery of oil from Athabaska tar sands, the mechanism of detergency and of the inhibition of corrosion by silicates and chromates, the high-temperature corrosion of heat-resistant alloys, the evaluation of anti-freeze materials as regards the corrosion of the cooling system of internal combustion engines, and the occurrence, purification and chemistry of natural and synthetic unsaturated fatty acids. Problems relating to the use of a Canadian-produced synthetic rubber have been investigated in collaboration with the Polymer Corporation, and work on the catalytic oxidation of ethylene to ethylene oxide has been directed towards acquiring the engineering data for the design of a pilot plant. Some work has been done in extension of Reppe's work on the synthesis of acetylene derivatives. Investigations in the Division of Mechanical Engineering have included further work on the control and stability of tailless aircraft and on the model of the Fraser River, and problems in connexion with the use of fuels and lubricants at low temperatures. The design and construction of special instruments required in the laboratories is a responsibility of the instrument laboratory.

The Division of Physics made plans for a spectroscopy group in July 1948, and the building up of equipment for precision electrical standards and work continued on the thermostatic control of refrigerator cars as well as on the colorimetry of railway fusees. Investigations were initiated on the possibilities of a camera mount with very soft restraints for minimizing the effect of pitch, yaw and roll on image movement in air photography and on the factors affecting the resolving power in a print made by a projection. The Division of Radio and Electrical Engineering was occupied mainly in fundamental research in radar and radiophysics and application of radar techniques to peace-time problems, including the development of two electrostatic generators of the Van de Graaff type and a study of methods of applying Shoran radar techniques in measuring the distance between two fixed points on the ground with sufficient accuracy for geodetic purposes and in determining the position of an aircraft engaged in taking photographs at intervals along a flight line.

The research programme of the Division of Medical Research is entirely extra-mural, and 118 projects were supported during the year, including fundamental research on such subjects as the physiology and biochemistry of muscular activity, cellular development, growth, destruction and regeneration; the physiology and biochemistry of nervous and special-sense activity; mechanisms of secretion; metabolic studies, including the role of vitamins; and studies on blood constituents, including the cells, enzymes, lipids and clotting agents. Thirty medical fellowships were held at seven universities during the year; the Council also granted 169 scholarships for postgraduate work, and 148 were actually held as against 145 in the previous year, mainly in physics (51), physical chemistry (29), chemistry (14) and organic chemistry (13). The work of the Technical Information Service also substantially increased, and the section now handles about four hundred inquiries a month. Pending the development of a national library in Canada, the library of the Council endeavours to provide some of the services which the science branch of such a national library might give.

RESIDENTIAL COURSES FOR SUPERVISORS

AMONG the subjects discussed at the British Institute of Management Conference at Margate in 1949 was whether there is a need for short residential courses to be provided on a national scale for foremen and supervisors. The subject was introduced by Major W. F. Scott, director of training to Tube Investments, Ltd., who stated that during the past thirty years the number of people employed in large businesses has greatly increased, processes of production have become much more scientific, and autocratic management has either yielded place to democratic or is fighting a hopeless rearguard action. Industry rests to-day upon the willingness of the operative to perform his task, and the supervisor is the propeller shaft linking the motive power of management with the operative. The link, therefore, should be fit for its important function, and this implies good initial selection and training of supervisors followed by some method of ensuring that he is kept up to date on all developments, technical, administrative and psychological, which affect his daily life.

Under the old order, the foreman's principal tool of control was the power of dismissal, but the stress and strains of war and the need for higher production under the conditions of the Essential Work's Order laid bare the weaknesses in this system. In most factories it was necessary to introduce one ancillary department after another, and each of them removed from the foreman's authority some function which had previously been his unchallenged prerogative. In the pressure of events, little was done to make him understand why changes were necessary.

Efforts to solve the difficulty were made by many technical colleges, which arranged special courses for foremen during the evenings; but their total impact on the problem was small. The Training Within Industry Scheme which was introduced from the United States also proved a useful help to the supervisor; but it did little to re-orientate him to the changed environment of an industrial world of full employment and a more complicated administrative structure. Supervisors' societies have also grown in number, and the Institute of Industrial Supervisors has come into being for the express purpose of helping its members to a better understanding of their jobs.

It is significant, however, that several large industrial organisations have come to the conclusion that something more is needed and have instituted internal courses for their supervisors. A few of these courses are residential in character, and with these,

Major Scott suggested, the advantages accruing from residence outweighed the added cost involved. But there are few concerns in Great Britain which are big enough to be able to organise their own courses and, if there is need for additional training facilities beyond those provided by technical colleges, the need must be met by industry combining to provide the instruction required under the conditions which will make it most effective. Residential training is essential owing to the short time that supervisors can be away from their jobs and because it ensures that every waking hour of that absence will play its part in making the training effective.

During the discussion most speakers agreed that such residential establishments could play a useful part in national recovery, although Mr. R. R. Hopkins, of Vauxhall Motors, Ltd., believed that the number of men who would benefit from fortnightly courses would be so small that it might be better to arrange for a much bigger number of foremen to attend courses of shorter duration. Dr. I. Blain, of the National Institute of Industrial Psychology, described experiences which had been obtained during an investigation which some members of the Institute's staff have been carrying out during the last few months. Foremen who have already attended such courses as these proposed by Major Scott believe that the real value of the courses comes from personal contacts rather than from the content of the course. Supervisors find it difficult to understand the general principles which it is feasible to teach them in a course of a rather academic type, and they do not know how to apply these general principles to the specific practice which holds in their organisations. Such courses, therefore, should be supplementary only to the training processes which should go on continuously within the individual companies. Mr. N. C. Rimmer, of the British Institute of Management, brought out the important point that the number of people attending each course should be limited and also that the atmosphere provided should be conducive to development of the co-operative spirit.

A plenary session of the Conference agreed that residential courses for foremen training should be set up throughout the country and that the British Institute of Management should use its efforts to further the study of the problem, to stimulate the provision of facilities in all suitable establishments, to co-ordinate and assist endeavours, to promote further experiments, and to encourage the full use by industry of the opportunities so provided.

T. H. Hawkins

M.K.S. SYSTEM OF ELECTRICAL UNITS

IT is now some forty-nine years since Prof. Giorgi first put forward his proposal for the establishment of a system of units based on the electrotechnical practical units together with the metre, the kilogram and the second as an alternative to the centimetre–gram–second electrostatic and electromagnetic systems. This system of Prof. Giorgi, now commonly known as the M.K.S. System, was accepted by the International Electrotechnical Commission in 1935, and in 1948 the absolute volt and absolute ampere were introduced internationally as a result of a decision of the Comité International des Poids et Mesures taken in 1946.

It might be thought that a matter upon which these international decisions had been taken after searching examination over so long a period would be one in which there could be little room for further discussion, and that by this time the M.K.S. System would have taken its place in the general practice of electrical engineering. "Future practice," wrote Giorgi in his memorandum of 1934 for the International Electrotechnical Commission, "will show which units are the most convenient for every particular purpose and the law of the 'survival of the fittest' will receive application." The fact is, however, that the adoption of the M.K.S. System has proceeded relatively slowly.

In two publications recently reprinted from Philips Research Reports, "The Rationalised Giorgi System and its Consequences" by P. Cornelius and H. C. Hamaker, and "Proposals and Recommendations Concerning the Definitions and Units of Electromagnetic Quantities" by P. Cornelius, the essential features of the M.K.S. System are re-stated, the position of the system reviewed and specific recommendations are made regarding it. It is particularly interesting that these two papers originate from an industrial organisation, as one of the reasons sometimes adduced for the slow progress in the adoption of M.K.S. units is that the main advantages of the system lie rather in the academic sphere and that the practising engineer or scientific worker is not as a rule greatly concerned about the matter. The first-mentioned paper gives an excellent account of the basis of the system and deals in some detail with the various controversial issues which have emerged in connexion with it, notably that of the E—H and E—B analogies. The case for rationalization, which is not, of course, specific to the M.K.S. System but has become inextricably linked with it, is cogently argued.

University and technical college teachers of pure or applied science will find much of interest in these communications. The ultimate benefit to the science and practice of electrical engineering of teaching students on the basis of a single unitary system can scarcely be called in question, and the problem of how best to incorporate M.K.S. units into the general structure of electrical engineering courses has become an urgent matter. It may be noted, in this connexion, that on March 30 a symposium of papers on the M.K.S. System of units will be presented to the Institution of Electrical Engineers.

James Greig

ENERGY OF THE STARS

THE Halley Lecture for 1949 was delivered at Oxford on May 12 by Dr. R. d'E. Atkinson, who chose "The Energy of the Stars" for his subject (*The Observatory*, **69**, 851; October 1949); as its scope is very comprehensive, it is quite impossible to give more than a mere outline of the points dealt with.

In the Lecture a short historical sketch is given of the problem of stellar energy from the days when it was thought that radioactivity provided a solution, up to recent times. This deals with the work of Eddington, Gamow, Houtermans, Russell and many others, including that of Atkinson himself, who has devoted a considerable amount of time to the subject during the past twenty years. Present nuclear theories are unsatisfactory in certain respects, and

among the difficulties confronting them may be mentioned that of the energy development of the diffuse giants which stand off the main sequence in such a manner that their energy source cannot easily be reconciled with that of other stars. Explanations have been attempted, but are not entirely satisfactory; and it is suggested that a solution may ultimately be found connected with an important factor—the true distribution of the stars in space.

It is well known that the bright main-sequence stars lie close to the plane of the galaxy, while the diffuse red giants are scattered much more uniformly, and also that the former are conspicuously absent from globular clusters. Some five years ago, Baade found that certain nearby galaxies show similar characteristics, and it is suggested that rotation may be connected with these factors. Many bright stars are rotating rapidly and also revolving with high speed round the centre of the galaxy—unlike the red giants and the globular clusters—and rotation may have an important influence on energy generation. It seems possible that a star which has very little axial rotation could condense in its central regions to an extent that would be difficult if it were rotating rapidly. Although it is probable that such a dense core would involve a temperature sufficiently high for the Bethe cycle to operate, it seems unlikely that the Bethe cycle would lead to stars of this nature as well as to main-sequence stars. Even if the core were sufficiently dense for its gravitational energy to suffice for a long-term energy supply, it is admitted that a very high density would be required.

One serious problem that seems almost intractable is the inadequacy of the 0·008 mass-excess of the hydrogen atom to keep a bright star shining for a long period even on the assumption that it started as practically pure hydrogen and is now nearly pure helium. No star which is 125 times as bright as the sun, and which fits the mass-luminosity relation, can live at this rate as long as the sun has lived, assuming that synthesis is its only source of energy; and it is difficult to account for those stars which have 100,000 times the luminosity of the sun and only 100 times its mass. Either such stars must be very young—a most improbable supposition—or they have become bright in recent times; but even then they would have very little hydrogen left.

Towards the end of the Lecture, reference is made to the work of Bondi and Gold (*Mon. Not. Roy. Astro. Soc.*, 108, 262; 1948) which suggests the continuous generation of matter out of nothing. Assuming that such matter is hydrogen, it would assist in explaining stellar energy provided it could be collected by the stars; but it is very improbable that this could be done with sufficient rapidity. In addition, the hydrogen accretions should penetrate the deep interiors of the stars, and it is difficult to see how this can be done, because the heat produced by impact would stop the motion downwards. Another point which arises is the retardation of rotation by the collection of diffuse extraneous matter; but, as already pointed out, the bright stars are rotating rapidly. One way of surmounting the difficulty—although the General Theory of Relativity does not suggest it—is to restrict this spontaneous generation of matter to places where there is a large amount of matter—the interiors of massive stars. If, however, the diffuse giants are to be included in this scheme, it may be necessary to postulate that the process cannot occur in non-rotating stars.

One tentative suggestion is made. If a very massive star continued to increase more and more, the final result would be that things would get out of control and an explosion would occur which would not result in a mere supernova but in a new expanding universe. The star would disintegrate into portions, each of which would become a new galaxy, and as new supplies of uranium and other radioactive elements would be produced at the same time, the universe resulting from the explosion might show signs of having started at a definite date. It is admitted, however, that the concentration of the generation of matter in the interiors of stars must be regarded as a mere *ad hoc* speculation.

ASTRONOMY AND NAVIGATION

A PAPER by D. H. Sadler on "Astronomy and Navigation" in a recent number of *Occasional Notes of the Royal Astronomical Society* (**13**, 2; September 1949) will be very useful to all who are interested in astronomy as applied to navigation. Part 1 of the paper gives a short historical sketch of the subject and then provides an account of the relationship between the Royal Astronomical Society and navigation. This part will be of special interest to fellows of the Society, many of whom are probably unaware of the important part that the Society has played in the design of the "Nautical Almanac" and also in the contributions of a few of the fellows to nautical astronomy. Although the number of papers is small, they are very useful, and some of them must be regarded as highly valuable contributions to the subject.

Part 2 deals with modern developments—including radar—which raise the question, "Why the need for further development in astronomical navigation?". The answer to this question lies partly in the enormous ramifications in methods of navigation that have recently been developed, and navigators to-day must be capable of handling all of them. Hence the astronomer has still important work to do, not only in simplifying the principles but also in simplifying their application; and so navigational almanacs are essential to provide in the simplest manner, and to the necessary accuracy, the positions of those heavenly bodies which are used for navigation. A large portion of Part 2 is devoted to a description of the almanacs produced by various countries, and something is said about a few graphical and instrumental methods devised for the solution of the astronomical spherical triangle. In the last section of Part 2, "Observations", special reference is made to the latest sextants, in which random accelerations due to the motion of aircraft are smoothed out, the observations being automatically integrated over periods of one or two minutes. Unfortunately, the Coriolis acceleration cannot be smoothed out in this way, and special tables are required in this case.

Part 3, "The Future", deals, *inter alia*, with artificial satellites, about which the public has heard much in recent times. After considering certain problems connected with these bodies, the author sums up the situation in the words, "The almanac maker of the era of these artificial satellites would have his full share of problems—both in celestial mechanics and in tabulation".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Cosmic Rays and the Magnetic Field of the Sun

THE variation of the cosmic-ray intensity at sea-level with geomagnetic latitude shows a sharp change in slope in the region of 50°, the intensity remaining very nearly constant between this latitude and the pole. This latitude cut-off is present at a height of 30,000 ft.[1] and, according to Cosyns[2], still occurs at the same latitude at a pressure-level of 7 cm. mercury. Carmichael and Dymond's balloon flights[3], when compared with those of Pfotzer, also indicate no increase in intensity between 50° N. and 88° N.

The absence, even at great altitudes, of any increase in intensity with latitude, at latitudes greater than 50°, has been taken as an indication that the momentum spectrum of the primary radiation must be cut off at $\sim 3 \times 10^9$ eV./c. Jánossy[4] has suggested that this cut-off in the momentum spectrum may be due to the sun's magnetic field, since this would be expected to set a limit to the momentum of particles which can approach the earth. In addition to this latitude cut-off, there should also be a daily variation in the cosmic-ray intensity as the earth rotates relative to the directions which are forbidden by the solar field. The amplitude of this daily variation should increase with altitude, since the contribution to the total intensity of particles with low momentum increases with height. Rossi[5] estimated that this daily variation should be as much as 20 per cent at 35,000 ft. at latitude 48·7° and concluded that this was not in agreement with observation.

More recent calculations by Kane, Shanley and Wheeler[6], following a suggestion by Alfvén[7], showed that the daily variation to be expected would be a good deal smaller than this, due to the effect of particles scattered into periodic orbits in the sun's field by the magnetic field of the earth. They calculated the intensity in the forbidden cone due to these particles and concluded that there should still be a small variation at high altitudes. It should therefore be possible to check the solar magnetic field hypothesis by measuring the daily variation and comparing it with the theoretically expected value.

In calculating the daily variation, it is necessary to know the trajectories of the particles in the earth's field, and since these data have not been calculated for our latitude, the information has been obtained from the results of terrella experiments carried out by Malmfors[8]. He gives, in graphical form, the direction of arrival in the earth's field of particles of momenta between 2 and 10×10^9 eV./c which strike the earth in a vertical direction. This information has been used to calculate the minimum allowed momentum as a function of solar time. Following the method used by Rossi[5], the contribution to the total vertical intensity by particles in a given range of momentum has been estimated from the latitude variation at 30,000 ft. as measured by Biehl, Neher and Roesch[1]. From Kane, Shanley and Wheeler's calculations we know the intensity in the forbidden cone as a function of momentum, and the vertical intensity at 30,000 ft. can therefore be calculated as a function of solar time. The differences in intensity between day and night estimated in this way are given in Table 2.

Measurements of the cosmic-ray intensity have recently been made at 30,000 ft. in a Mosquito aircraft during the day and during the night using a three-fold-coincidence set. The set consisted of three trays of Geiger–Müller counters each with a sensitive area of 20 cm. × 20 cm., the distance between the top and bottom trays being 43 cm. The telescope contained no absorber apart from 3·5 cm. of steel plate which supported the lead blocks used for shielding the counters from side showers. The apparatus was carried in the aircraft bomb-bay and the counting-rate was $\sim$ 33,000 per hour at 30,000 ft. Each flight was made along approximately the same route (between Leeds and the south coast of England) at an indicated height of 30,000 ft. with the altimeter set to 1013 mb. The flights were made during the period November 1–3, 1949, and the results are given in Table 1.

Table 1

Total duration of flights	Time centred on	Mean height	Average rate/hr.
2h. 50m.	00h. 42m.	30,195 ft.	32,450 ± 213
2h. 50m.	14h. 45m.	30,279 ft.	32,660 ± 176

After correcting for the difference of 84 ft. in the mean heights for the day and night flights, the average counting-rates become 32,700 ± 213 per hour at night and 32,660 ± 176 during the day-time period.

The difference (day minus night) is $-0{\cdot}12 \pm 0{\cdot}83$ per cent. The errors quoted are the standard deviations obtained from the scatter in the numbers of particles counted during 5-minute periods throughout the flights. The expected differences calculated for two values of the sun's magnetic moment M_s are as follows:

Table 2

H equator (gauss)	M_s (gauss cm.^{3})	Intensity, day minus night	Latitude cut-off
38	$1{\cdot}3 \times 10^{34}$	+ 3·5 per cent	50°
30	$1{\cdot}0 \times 10^{34}$	+ 1·9 "	53°

The calculated values of 3·5 per cent and 1·9 per cent differ from the measured value by an amount which is 4·4 and 2·4 times the standard deviation respectively. It therefore seems unlikely, on the basis of present theory, that the latitude cut-off at 50° can be due to the sun's magnetic field. It is of interest to note here that Biehl, Neher and Roesch have used their aeroplane data to normalize earlier balloon results obtained by Millikan and his co-workers. The normalized curves obtained in this manner indicate that there is no latitude cut-off at heights appreciably greater than 30,000 ft. up to latitude 60°. This result would appear to be in contradiction with the results of Cosyns and of Carmichael and Dymond, which are quoted above.

It is a pleasure to acknowledge the enthusiastic co-operation of Group-Captain J. C. Macdonald and his staff at the R.A.F. Station, Coningsby. We also wish to express our gratitude to the Department of Scientific and Industrial Research for a grant

covering the cost of the apparatus, which was built by Cinema-Television, Ltd.

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Distribution of Radiation from the Undisturbed Sun at a Wave-length of 60 cm.

Some theories of the emission of radio waves from the sun in the absence of sunspots[1,2,3] predict apparent 'brightening' of the limb at wave-lengths of the order of 60 cm. and shorter. It is therefore of interest to measure the distribution of 'radio brightness' across the solar disk at these wave-lengths.

One possible method of measuring this distribution is to observe the variation of the intensity received during an eclipse, as has been done by Dicke and Beringer[4] on a wave-length of 1·25 cm., Sander[5] on 3·2 cm., Covington[6] on 10·7 cm., Laffineur, Michard, Steinberg and Zisler[7] on 25 cm. and 55 cm., and by Christiansen, Yabsley and Mills[8] on 50 cm. I have also made similar measurements on a wave-length of 60 cm. during the partial eclipse of April 28, 1949.

Unfortunately, except for eclipses which are nearly total, the fractions of the disk and of a ring at the limb which are eclipsed are nearly equal, so that a clear indication of 'limb-brightening' cannot be expected. The interpretation of the results of eclipse observations is also made difficult by the presence of sunspots, which may emit enhanced radiation. Christiansen, Yabsley and Mills, whose results were obtained during an eclipse which was nearly total, made careful allowance for the emission from sunspots, and they concluded that their results would be consistent either with the presence of 'limb-brightening' or with the emission from a disk of uniform apparent temperature having a radius 1·3 times that of the visible disk. They deduced that half the total radiation originated near or beyond the visible limb.

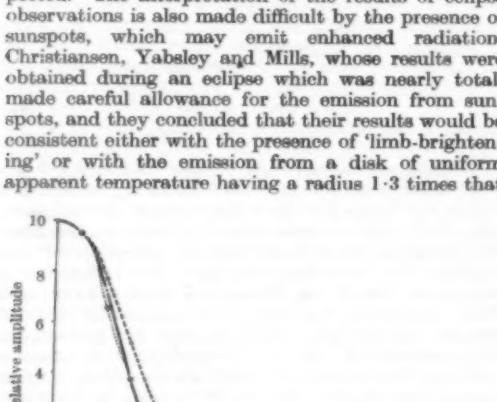

Fig. 1. The 'visibility' of the fringes as a function of the aerial spacing

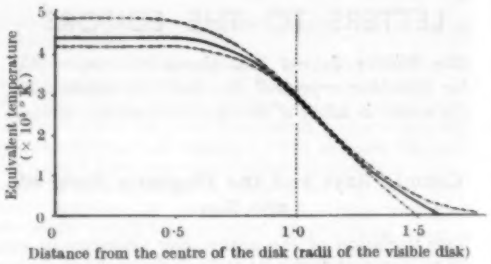

Fig. 2. Deduced distribution of radio 'brightness' across the solar disk. —·—·—, Estimated maximum error

In view of the difficulty of interpreting observations made during eclipses, the distribution of 'brightness' at a wave-length of 60 cm. has been investigated using a different method, which has the advantage that it can be employed at a chosen time when the contribution from sunspots is small. This method makes use of the principle employed by Michelson for measuring the angular diameters of stars. Two aerials, spaced many wave-lengths apart, are connected to the same receiver so that, as shown by Ryle and Vonberg[8], they produce a 'reception polar diagram' which is periodic in received power and which sweeps across the sun as the earth rotates. If the source were concentrated in the form of a strip parallel to the earth's equatorial plane, it can be shown that the relative amplitude of the variations in the received power (the 'visibility' of the fringes in Michelson's interferometer) would be proportional to that Fourier component of the intensity distribution in the strip which corresponds to the periodicity of the reception polar diagram.

Observations were made with a number of different aerial spacings, and from these it was possible to make a Fourier synthesis of the equivalent strip distribution of 'radio brightness'. From this distribution the radial distribution of brightness of the actual source can be derived if circular symmetry is assumed.

The experiment was carried out using aerial spacings up to 365 wave-lengths, on three separate occasions when the area of visible sunspots was small. The measured 'visibilities' for the different spacings are shown in Fig. 1. From each of the curves of Fig. 1 the distribution of brightness of an equivalent 'strip' source was found. By examination of these distributions it was possible to deduce the small contributions of the sunspots which were known to be present on each occasion, and hence to derive a curve corresponding to the radiation from the undisturbed sun. The radial distribution of 'brightness' for the undisturbed sun was then calculated from this curve. This 'brightness', expressed in terms of the temperature of a black body which would produce equal intrinsic brightness, is shown in Fig. 2.

It can be seen that at 60 cm. no limb-brightening occurs. The intensity at the limb is about 66 per cent of that near the centre of the disk; about 30 per cent of the total radiation comes from outside the visible disk.

The intensity of solar radiation is often expressed in terms of the temperature of an equivalent 'black' circular source subtending half a degree at the earth. This equivalent temperature, for a wave-length of

60 cm. and in the absence of sunspots, is found to be $5{\cdot}4 \pm 0{\cdot}5 \times 10^3$ deg. K.

This work was carried out as part of a programme of radio research supported at the Cavendish Laboratory by a grant from the Department of Scientific and Industrial Research. I am indebted to Mr. M. Ryle for considerable help, and to the Ministry of Education for a grant under the Further Education and Training Scheme.

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Heavy Fragment Disintegrations

A star (Fig. 1) has been observed in Ilford *G5* nuclear research emulsion exposed on the Jungfraujoch. It consists of three lightly ionizing particles and three singly charged particles emitted nearly in the same direction. The ranges of these particles, which all end in the emulsion, are 31 μ, 61 μ and 88 μ respectively, which is nearly in the ratio 1 : 2 : 3. The deviations from exact proportionality may be accounted for by straggling.

The range of a particle in the emulsion is given by an expression of the type

$$R = \frac{m}{e^2} f(v),$$

where m is mass, e is charge and v is velocity of the particle. If, therefore, these three particles have equal charges and initial velocities, their ranges will be proportional to their masses. This indicates that the particles have masses in the ratios 1 : 2 : 3 and are therefore proton, deuteron and triton respectively.

This observation may be explained by assuming that an excited lithium nucleus was ejected from a nucleus in the emulsion by a cosmic ray particle, and disintegrated as it left the parent nucleus :

$$Li_3^6 \rightarrow H_1^1 + H_1^2 + H_1^3 - 21{\cdot}3 \text{ MeV.}, \quad (1)$$

or $$Li_3^7 \rightarrow H_1^1 + H_1^2 + H_1^3 + n_0^1 - 28{\cdot}4 \text{ MeV.} \quad (2)$$

No other lithium isotope can give a disintegration consistent with the observed tracks.

Examination of the modes of disintegration of Li_3^6 and Li_3^7 shows that in neither case is the above reaction energetically the most favoured. But, if the spins of the disintegration products in reaction (1) are all parallel, they total 2, whereas the maximum total for any of the energetically more favoured reactions is 1. If, therefore, the spin of the excited Li_3^6 nucleus is assumed to be 2, then reaction (1) will be permitted and the alternatives forbidden.

It is not possible to permit reaction (2) and forbid its alternatives in a similar manner.

The event may therefore be explained as the disintegration of an excited Li_3^6 nucleus of spin 2 according to equation (1). As this reaction is endothermic, the lithium nucleus must have been excited to more than 21·3 MeV. The excess excitation energy over this value, if any, would appear as kinetic energy of the disintegration products in the centre of mass system. This would have caused a distortion of the range ratios or an angular spread of the tracks, or both, depending on the angles of emission of the particles. None is, in fact, observed. It seems likely, therefore, that the excited state of the lithium nucleus is not much greater than 21·3 MeV.

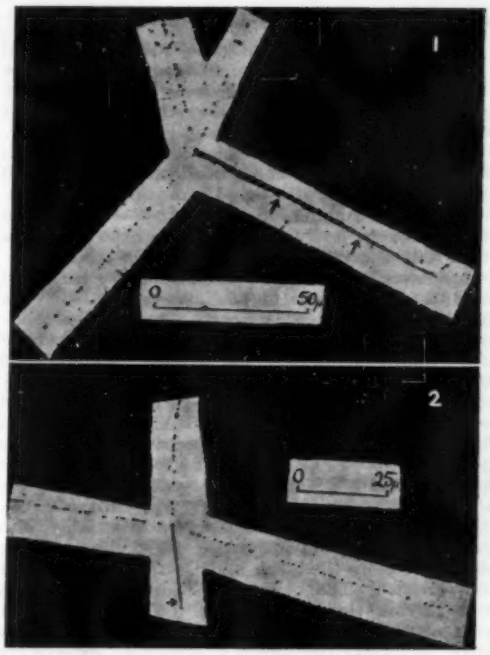

Fig. 1. A proton, deuteron and triton emitted in the same direction from a cosmic-ray star. The ends of the proton and deuteron are indicated by arrows. The deuteron ends very nearly in the triton track and so is not easily visible. Observer : Miss E. V. Le Good

Fig. 2. Two singly charged particles emitted in the same direction. The tracks are in the same vertical plane and are not resolved in the picture. The end of the shorter track is indicated by an arrow. Observer : P. E. Hodgson

In another event (Fig. 2) observed in *C2* emulsion, two tracks, of ranges 22·5 μ and 24 μ, are due to singly charged particles emitted nearly in the same direction. This event may be explained in a similar way by either of the reactions :

$$He_2^4 \rightarrow 2H_1^2 - 23{\cdot}8 \text{ MeV.}$$
$$He_2^6 \rightarrow 2H_1^3 - 12{\cdot}2 \text{ MeV.}$$

The probability that these events are due to the chance coincidence of evaporated particles is negligible for the first and very small for the second.

In both events the particles are emitted nearly in a horizontal plane.

I should like to express my thanks to Sir George Thomson and Mr. N. C. Barford for discussion of the above events.

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Radioactivity of Potassium

THE following determinations of the specific β- and γ-ray activities of potassium-40 are reported in view of the current interest in its decay scheme and the uncertainties which exist as to the magnitude of some of its constants[1–3].

Gamma-ray activity. A steel condenser-ionization chamber[4] of one litre volume, filled with nitrogen at 50 atmospheres pressure, was used to measure the γ-radiation from a 2-kgm. source of 'AnalaR' potassium chloride which closely surrounded it in the form of a thick-walled cylinder. The sensitivity of the arrangement was such that the potassium chloride contributed an ionization current of 150 ions/c.c./sec. above a background of 65 ions/c.c./sec. Calibration was made (*a*) by the insertion into the potassium chloride of four tubes containing pitchblende, standardized against a radium needle of known content, and (*b*) by an internal standard of sodium-24 intimately mixed with the potassium chloride. Taking the accepted figure[5] of 1·5 MeV. for the quantum energy of the potassium-40 γ-ray, the pitchblende calibration gave a value of 3·0 quanta/sec./gm. potassium, and the sodium-24 measurements gave 2·9$_8$ quanta/sec./gm. potassium. These results compare reasonably with values of 3·6 and 3·3 quanta/sec./gm. potassium given respectively by Gleditsch and Graf[3] and by Ahrens and Evans[2]. The original measurements of Gray and Tarrant[6] lead to a value 0·6 quanta/sec./gm. potassium, but this value is now known to be in error. Dr. Gray has kindly re-examined some of the earlier data, and the major part of the discrepancy has been accounted for.

Beta-ray activity. Disks of potassium chloride were made by pressing with a little binding material and placed below the end-window of a type *GM*4 Geiger–Müller tube. Calibration was again by means of an internal standard of sodium-24. Since the β-ray energies of potassium-40 and sodium-24 are nearly equal, the effects of self-absorption and reflexion are eliminated in a comparison of their activities when incorporated in the same specimen. The results do not then depend on the specimen thickness:

Specimen thickness (mm.)	1	2	3	4
β-ray activity mμC./gm. KCl	0·431	0·426	0·438	0·436

Corrections were determined experimentally to allow for the effect of γ-rays on the observed counts. The mean value obtained for the potassium-40 β-ray activity was 30·5 β-particles/sec./gm. potassium.

Stout[7] has recently published similar β-ray measurements, using thin specimens and calibration by internal sodium-24 standard. He reports a β-ray activity for potassium-40 of 30·0 ± 6 β-particles/sec./gm. potassium, in very close agreement with the value reported above. Ahrens and Evans[2] have made an estimate of 34 β-particles/sec./gm. potassium based on a critical examination of earlier values by Mühlhof[8] (25 β's/sec./gm. potassium) and by Bleuler and Gabriel[9] (59 β's/sec./gm. potassium).

Ahrens and Evans[2] have proposed a branching decay scheme for potassium-40 (based on some observations of the calcium-40 to potassium-40 ratio in Pre-Cambrian lepidolites) in which 42 per cent of the potassium-40 atoms disintegrate by β-ray emission to calcium-40, 54 per cent by electron capture to the ground-state of argon-40 and 4 per cent by electron capture to a metastable state of argon-40 and then to the ground-state with γ-ray emission. On this basis, Ahrens and Evans deduce a total half-life of $5·1 \times 10^9$ yr.; the experimental values of the β- and γ-ray activities reported above lead, on the same scheme, to a total half-life of $5·5 \times 10^9$ years. Both figures are more than twice the half-life of $2·4 \times 10^9$ yr. deduced by Bleuler and Gabriel[9], and this longer half-life is sufficient to remove most of the difficulties which must arise, as Poole[1] demonstrates, in any attempt to reconcile a potassium half-life of $2·4 \times 10^9$ yr. with present estimates of the age and potassium content of the earth's crust. On the basis of data given in Poole's letter and a potassium half-life of $5·5 \times 10^9$ years, potassium-40 disintegration would account for about half the argon now present in the earth's atmosphere. Verhougen has pointed out[3] that the half-life suggested by Ahrens and Evans still leads to remarkable conclusions about the solidification of the earth's crust. The relative magnitude of the electron-capture branch of Ahrens and Evans's scheme for potassium-40, however, is not yet fixed very precisely, and can only be determined accurately by measurement of the argon *K*-radiation which follows the electron capture process.

Finally, it may be added that with an average potassium content of tissues of about 0·11 per cent, the β- and γ-radiations of potassium-40 contribute a weekly dose to humans of approximately 0·25 mr. or one-third that received in the same time from cosmic radiation at sea-level. The inclusion of the argon *K*-radiation of 3·2 ekV. would raise this figure by less than 1 per cent. The γ-radiation from potassium in the body is the equivalent of about 6×10^{-3} μgm. radium, a figure of the same order of magnitude as the supposed normal radium content of the skeleton.

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Nov. 29.

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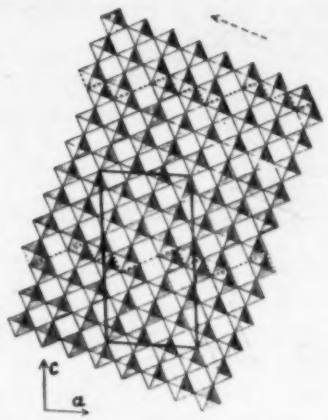
Structure of β-Tungsten Oxide

BY prolonged heating at 1,000° C. of the blue β-tungsten oxide of composition $WO_{2.90}$, formed by heating appropriate mixtures of tungsten powder and tungsten trioxide *in vacuo*, minute crystal needles were produced, suitable for single crystal investigation[1]. On the basis of X-ray data obtained in this way, it has been possible to work out the structure of this compound.

The Weissenberg photographs of the oxide are rather peculiar in appearance, the reflexions generally occurring in doublets or triplets. When represented in reciprocal space, the groups of reflexions were found to be situated in the immediate vicinity of the reciprocal lattice points corresponding to an approximately cubic unit cell with the edge-length equal to 3·75 A., while the dimensions of the actual monoclinic unit cell are $a = 12·1$ A., $b = 3·78$ A., $c = 23·4$ A., $\beta = 95°$. The regular decrease with increasing θ in the intensities of the strongest reflexion in each group and the dimensions of the substructure cell suggested that the structure is closely related to the DO_3-type (ReO_3-type)[2]. From this starting-point



the positions of the tungsten atoms could be derived through successive Fourier calculations of the electron density function. Sites of the oxygen atoms were found from space considerations. In this way a structure of the symmetry $P2/m$ was arrived at, having the cell content $W_{20}O_{58}$ and giving satisfactory agreement between observed and calculated structure-factor values.

The accompanying figure represents an idealized picture of the structure. The lattice may be described as consisting of 'blocks' of WO_6 octahedra joined by sharing corners, the 'blocks' being infinitely extended in two dimensions, and of a characteristic width of twenty octahedra in a third direction (indicated by a dotted arrow in the figure). The 'blocks' are mutually connected by octahedra-sharing edges. The projections of the folded planes common to the 'blocks' are marked with dotted lines. The WO_6 octahedra are almost regular except those sharing edges with other octahedra, which are somewhat distorted.

The structure is related to those of β-molybdenum oxide (Mo_4O_{11}) and β′-molybdenum oxide (Mo_9O_{26})[2], but differs concerning the width and the mutual combination of the 'blocks'. Furthermore, the octahedra of the molybdenum oxides are generally less regular than those of the tungsten oxide. This may be compared with the structures of the trioxides; tungsten trioxide, crystallizing with a deformed DO_3-lattice[4], whereas molybdenum trioxide has quite another structure[4,5]. Tungsten thus seems more capable than molybdenum of forming a DO_3-lattice. This is also of interest considering the non-existence of a molybdenum analogue of the highly stable sodium tungsten bronze of perovskite type, which may be at least formally described as an interstitial solution of alkali ions in a DO_3-lattice[6].

A detailed report of the investigation will be published elsewhere[7].

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A Radioactive Method for Measuring the Adsorption of Dissolved Substances on Liquid Surfaces

SEVERAL valuable and interesting methods[1] have been devised for the measurement of the adsorption of soluble substances on the surface of a solution, from the moving bubble method initiated by Donnan and his students to the microtome and interferometer methods by McBain *et al.* For measurements on static interfaces, the microtome and interferometer methods seem to have been the only applicable ones, and several fundamental problems have been attacked with these methods. For extensive study in this wide field, however, any simple and accurate method is welcome.

The radioactive method to be described here is based on the use of isotopes emitting non-penetrating radiations, like alpha-emitters and the soft beta-emitters such as carbon-14, sulphur-35, calcium-45 and hydrogen-3.

The principle of the experimental arrangement used is the following. A thin-window bell-type Geiger–Müller tube is placed immediately above a circular cup filled exactly to the brim with a solution of the surface-active compound tagged with a built-in radioactive isotope or with a solution of a radioactive ion. The Geiger–Müller tube counts the particles from the surface-adsorbed molecules or ions, and also those from the interior of the solution. However, the fraction of the particles from the interior that is counted decreases very rapidly with the depth below the surface, so that under favourable conditions nearly all the particles counted originate in the surface-adsorbed layer. The fraction of the particles coming from the interior is determined by making a similar measurement with a solution of the same isotope in a non-surface-active compound.

The recoil atoms from alpha- and beta-disintegrations in the natural radioactive series might also be used, but they cannot be counted directly with conventional Geiger–Müller tubes; since they are usually radioactive in turn and charged, however, they can be collected on an electrode in the gas over the surface and measured radioactively.

The method applied to $C_{18}H_{37}SO_4Na$ (probably not entirely free from homologues) labelled with sulphur-35 gave quantity adsorbed on the surface as $6{\cdot}05 \times 10^{-10}$ moles/cm.^{2} in a $1{\cdot}6 \times 10^{-3}$ N solution at 18° C. From surface tension measurements with a Du Noüy tensiometer in the concentration range from $0{\cdot}5 \times 10^{-4}$ to 5×10^{-4} N, the surface-adsorbed quantity was calculated with Gibbs's adsorption equation:

$$-\Gamma = \frac{\partial \gamma}{\partial \mu}; \quad \partial \mu = RT\,(\partial \ln c + \partial \ln f),$$

where γ is surface tension in dynes/cm., μ is Gibbs's partial free energy of the solute, c is concentration and f is activity coefficient of the solute.

In these dilute solutions well below the critical concentration for micelle formation[8] $\partial \ln f / \partial \ln c$ is negligible, so that

$$\Gamma = -\frac{1}{RT}\,\frac{\partial \gamma}{\partial \ln c}.$$

Hence $\Gamma = 5{\cdot}8 \times 10^{-10}$ mole/cm.^{2}, which is in fair agreement with the directly measured $6{\cdot}05 \times 10^{-10}$ mole/cm.^{2}, considering the sulphate was not quite pure and that the surface-tension measurements were not very accurate at such low concentrations.

A more crucial test of Gibbs's law will be undertaken with homologue-free C_{16}- and C_{14}-sulphates. In addition, investigations are being made on mixtures of surface-active agents in solution, co-adsorption of ions, etc., using the radioactive method.

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Light Output from a Spark 'Point Source'

IN view of the increasing use of high-speed shadow and *schlieren* photography by short-duration flashes from electric discharges, it seemed desirable to determine the various factors affecting the light output, so that desired characteristics could be obtained in the most convenient way.

It has been found that the light emitted by a given spark gap depends on the current in the gap and on its variation with time. The light is only affected by the voltage, capacitance and inductance of the discharge circuit in so far as these affect the current. For example, the same light output is obtained by the discharge of a 0·1 μF. condenser at 10 kV. through a circuit inductance of 0·4 μH. as by the discharge of a 0·033 μF. condenser at 30 kV. through a circuit inductance of 1·2 μH. giving the same oscillatory current of 5 k.amp. with period of 1·3 μsec. The upper curves in Fig. 1 indicate the dependence on current of the relative maximum light output (as measured by a photomultiplier, amplifier and cathode ray oscillograph) from a 1-mm. gap in air between rod electrodes carrying a lightly damped oscillatory current of period 1·3 μsec. The variation of light output with time is shown in Fig. 2, curve (*b*), which indicates that a substantial proportion of the total light is emitted in the first half-cycle of the discharge.

The peak light output is reduced if the time to maximum current exceeds 1 μsec., and the lower curves in Fig. 1 give the relative maximum light output for a discharge of period 40 μsec. With such a discharge between copper electrodes, the second and third half-cycles produce as much light as the first, suggesting that a stable arc condition has been established in a few microseconds. It is believed that, with discharges of the shorter period, a higher voltage remains on the gap during the first quarter-cycle, so that more energy is dissipated in the gap. It is intended to make voltage measurements.

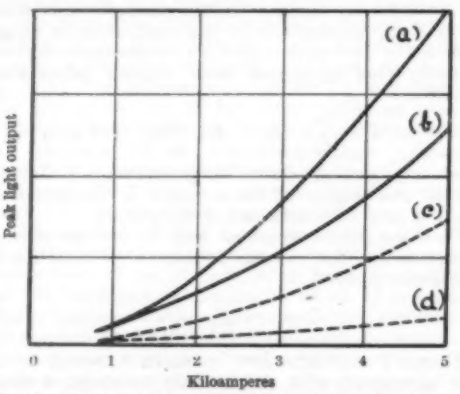

Fig. 1. Variation of peak light with current in 1-mm. gap: (*a*) and (*c*) cadmium electrodes; (*b*) and (*d*) copper electrodes; (*a*) and (*b*) discharge oscillation period 1·3 μsec.; (*c*) and (*d*) discharge oscillation period 40 μsec.

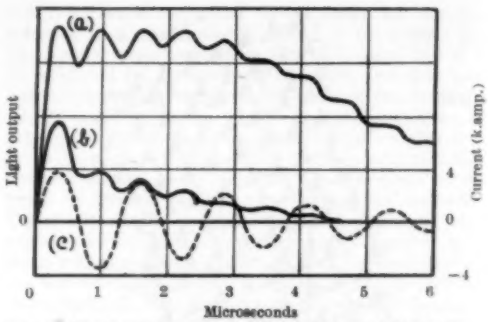

Fig. 2. Variation of current and light with time: (*a*) light from constricted 3-mm. axial gap; (*b*) light from open 1-mm. gap; (*c*) current

The maximum light output is greater for the more volatile metals, and the rate of decrease is less. For example, cadmium electrodes 1 mm. apart give about 50 per cent higher maximum, and 100 per cent more total light than copper electrodes.

An alternative form of spark, emitting light axially through a 1-mm. hole in one electrode, has been examined. If the spark is not constricted, it is usually not axial, and less light is available than is emitted radially from a 1-mm. gap between rods. With the discharge constricted by an insulating tube, measurements have been made on sparks 1½–8 mm. long. The maximum light emitted was about twice that from the open 1-mm. gap. The total light, as measured by a photo-electric integrating flashmeter, increased with gap-length, varying from five to eight times that for the open gap. A photomultiplier oscillogram showed that the increase in total light was obtained at a cost of increased duration, as much light being emitted during the second discharge half-cycle as in the first (Fig. 2, curve *a*).

The measurements of total light, for a discharge current of 4 k.amp., period 1·3 μsec., indicate that the 1-mm. open gap with copper electrodes, the 1-mm. open gap with cadmium or magnesium electrodes, and the constricted axial gaps with brass electrodes, were respectively equivalent to about 0·1, 0·2 and 0·6–0·9 candle-second.

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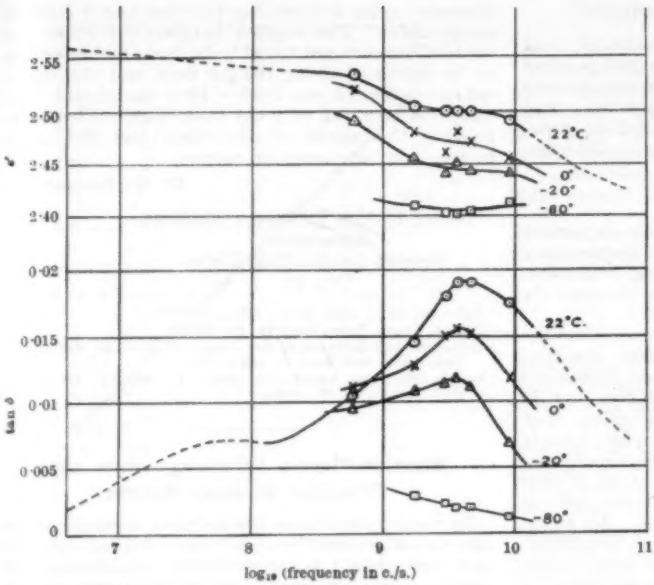
Dielectric Behaviour of Methyl Palmitate in the Microwave Region

THE variation of the dielectric constant and loss of methyl palmitate at room temperature over the frequency range 50 c./s. to 3×10^{10} c./s. was first reported by Dryden and Willis Jackson[1]. The evidence provided for resonance absorption in the frequency range centred on 10^{10} c./s. led us to investigate the absorption at room temperature and at as many



frequencies as practicable in the microwave region. All measurements except those at 10^{10} c./s. were made in a coaxial line using the standing-wave method of Roberts and von Hippel[2]. At 10^{10} c./s. the same method was used in a rectangular wave-guide carrying the H_{01} mode. The accuracy of this method is greatest when the specimen length is an odd number of quarter wave-lengths. Therefore at all frequencies the measurements were done with specimen lengths complying as nearly as possible with this condition. Cast specimens were first used, but were found to give inconsistent results. This was thought to be due to the non-uniform nature of the material prepared in this way, the average densities being much less than the crystal density of 1·007 gm./c.c. calculated from the spacing obtained by Malkin[3]. Specimens pressed from powder were found to have densities of $0{\cdot}985 \pm 0{\cdot}005$ gm./c.c. and have, therefore, been used throughout the investigation.

The results of measurements at $22 \pm 1°$ C. are shown in the accompanying graph. The experimental points represent the mean of several measurements with different specimens, and are in good agreement with the values in the microwave region given in a recent communication by Willis Jackson[4].

The value of tan δ at 600 Mc./s. reported here is, however, higher than the value obtained by interpolation in Jackson's curve. The parts of the curves of ε' and tan δ at 22° C. shown dotted in the graph are based on Jackson's results at frequencies outside the range covered in this investigation.

The plateau in the ε' curve in the frequency-region of maximum loss is, we believe, real. Although the absolute accuracy of the determination of ε' is not better than ± 1 per cent, the relative accuracy should be higher than this, since the same specimen was used in each series of measurements. This plateau suggests that the absorption mechanism may not be entirely of the Debye type.

To obtain further information regarding the absorption process, measurements were next carried out, using the same technique, at a number of lower temperatures. The results of the measurements at 0°, −20° and −80° C. are shown in the graph. The absolute accuracy of ε' is considered to be ± 1 per cent; but again the relative accuracy at any one temperature is probably better than this. The tan δ values are accurate to ± 5 per cent, except at −80° C., where the accuracy is somewhat lower.

The noticeable features of the experimental curves are: (*a*) The frequency of maximum absorption is independent of temperature. (*b*) The magnitude of the peak in the loss curve decreases with fall of temperature. (*c*) The plateau in the ε' curve persists at lower temperatures. There is even a suggestion of a kink at the frequency of maximum loss.

It is difficult to discuss the possible absorption mechanisms which might account for the experimental results until further work at lower temperatures has been carried out at frequencies less than 600 Mc./s. The change in tan δ with temperature at the lowest frequency (600 Mc./s.) used indicates that absorption of the Debye type is present, the loss-spectrum due to it moving to regions of lower frequency as the temperature falls. This also causes the symmetry of the tan δ curve to change with temperature. The persistent peak in the loss-curve around 4×10^9 c./s. is, however, not explainable by means of a relaxation process of the Debye type, and must, it is thought, be due to resonance occurring at a frequency within the relaxation spectrum. According to Fröhlich[5], however, loss due to pure resonance should increase at the resonant frequency as the temperature falls (the loss-curve becoming narrower in the process), whereas the present results do not show this effect. This may be due to resonance absorption occurring in the same frequency-range as Debye absorption.

To test the significance of the fact that methyl palmitate crystallizes in double molecules, further work is in progress on the behaviour of the methyl esters of other fatty acids, including those which do not crystallize in this manner.

Our thanks are due to Prof. J. E. Roberts for his interest in the investigation, to the Research Laboratories of Messrs. Unilever, Ltd., for providing the pure material, and to the Admiralty Signal and Radar Establishment for the loan of apparatus.

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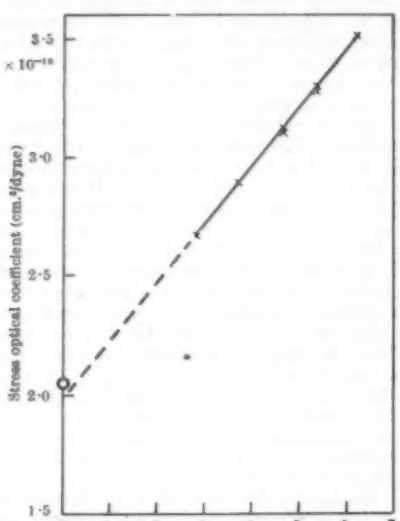
Birefringence in Rubbers

IT has been shown, both theoretically[1] and experimentally[2,3], that in simple elongation of a sample of a pure gum vulcanizate, an approximately linear relationship between the tensile stress t and the birefringence $(n_1 - n_2)$ obtains, provided the strain is not sufficiently large to produce crystallization. We may write

$$(n_1 - n_2) = Ct, \qquad (1)$$

where C, the constant of proportionality, is termed the 'stress-optical coefficient', and is theoretically independent of the degree of cross-linking (vulcanization) of the vulcanizate and should be identical for all pure rubbers.

Thibodeau and McPherson[3] have shown that the stress-optical coefficient is dependent upon the type of vulcanization. In particular, for gum vulcanized by means of sulphur without accelerators but in the presence of stearic acid and zinc oxide, they found the stress-optical coefficient to depend linearly on the amount of combined sulphur. This dependence upon degree of vulcanization suggests that the sulphur is modifying either the polarizability or the stiffness of the molecular chains of the network. An extrapolation of the linear relation to zero combined-sulphur content has been used by Treloar as a measure of the birefringence of the actual molecular network.



×—×—, Sulphur vulcanizate (Thibodeau and McPherson); O, peroxide vulcanizate (Saunders)

Recently a vulcanized rubber has been produced which is free from all additions to the rubber; particularly it is free from sulphur. The vulcanization is achieved by a peroxide reaction[4], and all the by-products can be removed, leaving a pure hydrocarbon vulcanizate. It is interesting to determine the stress-optical coefficient for this material and compare it with the results obtained by Thibodeau and McPherson.

The birefringence of a thin strip of the peroxide vulcanizate elongated under a known load was measured using crossed Nicol prisms and a Babinet compensator. The relation between the stress and the birefringence was found to be linear and reversible up to strains of about 100 per cent, and the stress-optical coefficient was $2{\cdot}05 \times 10^{-10}$ cm.²/dyne. This compares very well with the value obtained by extrapolating the results of Thibodeau and McPherson to zero combined-sulphur content.

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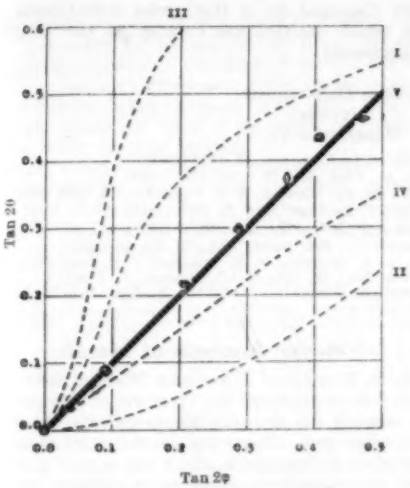
Elastico-Plastic Straining when the Principal Stresses Rotate

IN recent years there has arisen a controversy, on theoretical grounds[1], on whether post-yield straining of metals should be analysed by considering: (I) plastic increment-strain components only (Levy, about 1870, and Mises later[2]); (II) plastic total-strain components only attained instantaneously (Nadai, 1931 [3]); (III) plastic + elastic increment-strain components (Prandtl, 1924, and Reuss, 1930 [4]); (IV) plastic + elastic total-strain components attained incrementally (Swainger, 1945 [5]). It is shown in this communication that, from experimental evidence, none of these theories is correct; but that a simple modification to my theory in (IV) leads to correct predictions; that is, one must consider (V) plastic increment-strain components + elastic total-strain components attained incrementally.

This step was not taken arbitrarily, but reached from the consideration that continuity of straining-displacement[6] must be assured for a body *as a whole*, and its instantaneous shape under elastico-plastic straining should be the reference for the next increment of deformation.

A searching test of a theory predicting post-yield strain values is given by rotating the principal normal-stress system relative to the substance at a given point in the body. Peters, Dow and Batdorf[7] undertook the test by loading with combined axial compression and torsion on two thin-walled duralumin cylinders. Each cylinder was made to yield by axial compression stress S_{zz}, and then complex rotating stresses were induced by applying axial torsion to induce shear stress S_{zy}. In two tests the axial compression stress was maintained constant while applying shear, and the compression strain e_{zz} allowed to increase correspondingly as the shear strain $2e_{zy}$ increased. In a third test, the longitudinal compression strain was maintained constant while applying shear, and the longitudinal compression stress allowed to decrease correspondingly. The maximum strains were approximately 1·6 per cent compression and 0·7 per cent shear on the classical definition. Dr. Peters was kind enough to send me a copy of the N.A.C.A. paper in advance of publication[7].

Each theory states that the 'principal' directions θ, of the strains it considers, coincide with φ, those of the principal normal stresses in an isotropic sub-



stance. Hence correctness of this fundamental hypothesis for a given theory is shown by a point, calculated from experimental values, falling on the heavy line in the accompanying graph. Peters, Dow and Batdorf calculated the curves I and II. I have calculated III, IV and V after scaling values from the printed curves.

The points on curve V were found by measuring elastic total-strains e^E_{xx}, $2e^E_{xy}$ and plastic increment-strains de^P_{xx}, $2de^P_{xy}$ and, with the stress values substituted in

$$\tan 2\theta = \frac{2e^E_{xy} + 2de^P_{xy}}{(e^E_{xx} - e^E_{yy}) + (de^P_{xx} - de^P_{yy})}$$

$$\tan 2\varphi = \frac{2S_{xy}}{S_{xx}}. \qquad (1)$$

The scatter may be due in part to measuring values from printed curves in the absence of the arithmetical values.

There are two deficiencies in the theories 1–4. In 2 and 4 it was not seen clearly that only the plastic increment-strain is associated with the principal normal stresses. The total plastic strain has merely led to the instantaneous reference shape of the body. In 1, 2 and 3 it was not seen that the single-valuedness of displacement for body continuity precludes the extraction and consideration alone of a strain component of 'quality' or magnitude from the strain defining the instantaneous shape of the yielded body, which must be seen as a whole in the sense of ref. 6.

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Relativistic Interactions Between Two Nucleons

SEVERAL papers[1–4] dealing with the relativistic study of the two-body problem have recently been published. They may be classified in two groups according to the point of view adopted: stable state of the deuteron, or collision process.

A convenient method for dealing with both aspects is to expand the wave function Ψ of the deuteron with respect to the eigenfunction $\overset{(0)}{\varphi}_m$ of the nucleons (1) and (2) in momentum space:

$$\Psi = \Sigma\, \Psi_{m_1 m_2}\, \overset{(1)}{\varphi}_{m_1}\, \overset{(2)}{\varphi}_{m_2}, \qquad (1)$$

with $\Psi_{m_1 m_2} = -\Psi_{m_2 m_1}$ and $\overset{(0)}{\varphi}_m = \chi_m \exp i\,(p_m x^j - E_m t)$ without reducing the corresponding wave equation as was done by Kemmer[5].

(*a*) As Van Hove[1] did on the lines of the neutral pseudoscalar and vector meson theory, it is then possible to obtain a matrix element for the interaction between nucleons in which the direct coupling terms may disappear, showing that these terms do not play any part in the ground-state of the deuteron. However, Van Hove's general conclusions are not quite justified. For example, in the case of the pseudoscalar field, he maintains that the interaction completely vanishes to the static approximation, owing to the presence of the ρ_2 Dirac matrices in an expression of the type:

$$(\Psi \mid W_1 \mid \varphi) = \qquad (2)$$

$$-f_2^2 \Sigma\, \Psi_{n_1 n_2}\, \overset{(1)}{\chi}{}^*_{n_1} \overset{(2)}{\chi}{}^*_{n_2} \frac{\overset{(1)}{\rho_2}\, \overset{(2)}{\rho_2}}{\varepsilon_k^2 - (E_{m_1} - E_{n_1})^2}\, \overset{(1)}{\chi}_{m_1}\, \overset{(2)}{\chi}_{m_2}\, \varphi_{m_1 m_2}$$

$$f_2 = f_1 + 2f_2 \frac{M}{\varkappa},$$

where f_1, f_2 are the coupling constants between the pseudoscalar meson field and the nucleons, M and $\varkappa$ the masses of the nucleon and meson respectively, and ε_k is the total energy of the virtual meson involved. First of all, the assumption which consists in putting $\rho_2 = 0$ for all the components of (2) is too drastic when dealing with the stable states of the deuteron, which cannot in any event be represented by pure plane waves. Secondly, as was pointed out by Araki[3], the product $\left(f_2 \frac{M}{\varkappa}\right)^2 \overset{(1)}{\rho_2}\, \overset{(2)}{\rho_2}$ does not tend to zero for vanishing momenta; this fact is due to the mixture of the so-called 'small' and 'large' components in the wave function of the deuteron. It can also easily be seen by using a Gordon decomposition (cf. Rosenfeld[6]). Araki[3] pointed out that the r^{-3} singularity of the pseudoscalar static field is no longer valid at small distances of approach, being replaced by an r^{-1} singularity. Similar criticisms may be made for the vector field case.

(*b*) On the other hand, keeping only one term (Born approximation) in the expansion (1), one can obtain the relativistic cross-section for a neutron–proton collision. The results have been published for scalar[3] and pseudoscalar[4] meson fields. At least two procedures may be used to compare the calculations with the experimental data: (i) The interaction constants are adjusted in order to obtain agreement between the theoretical and experimental *differential*

cross-section[4] for some value of the angle of collision, and the results in the remaining angular domain are examined. This permits us to see the angular dependence of the cross-section for each kind of field. (ii) It also seems useful to try to relate the results at low energies with those at higher energies, in looking for the role of the relativistic corrections in the *total* cross-section[5]. Using, for example, a mixture of symmetrical pseudoscalar and vector fields, we get for the total cross-section, in the system of the centre of gravity, and neglecting terms of the fourth order in the momentum p of nucleons:

$$S = S_{NR}\left(1 - \frac{p^2}{M^2}\right) + \frac{p^2+M^2}{8\pi}\left\{\frac{10A}{\varkappa^2(\varkappa^2+4p^2)} - \frac{5A'}{4p^2}\left[\frac{1}{p^2}\log\frac{\varkappa^2+4p^2}{\varkappa^2} - \frac{4}{\varkappa^2}\frac{\varkappa^2+2p^2}{\varkappa^2+4p^2}\right] + \frac{B}{p^2(\varkappa^2+2p^2)}\log\frac{\varkappa^2+4p^2}{\varkappa^2}\right\}\frac{p^2}{M^2}$$

with

$$A = g_1^2\left(g_1 - 4g_2\frac{M}{\varkappa}\right) + g_2^2\left(4g_2^2\frac{M^2}{\varkappa^2} - f_2^2 - 2g_1^2 + 8g_1g_2\frac{M}{\varkappa}\right)$$

$$A' = g_1^4 + g_2^4 + g_1^2\left(g_1 - 4g_2\frac{M}{\varkappa}\right) - g_2^2\left(4g_2^2\frac{M^2}{\varkappa^2} - f_2^2 - 2g_1^2 + 8g_1g_2\frac{M}{\varkappa}\right)$$

$$B = g_1^2\left(4g_2^2\frac{M^2}{\varkappa^2} - f_2^2 - g_1^2 + 4g_1g_2\frac{M}{\varkappa}\right) - g_2^2\left(4g_2^2\frac{M^2}{\varkappa^2} - f_2^2 - 5g_1^2 + 20g_1g_2\frac{M}{\varkappa}\right) + 8g_1g_2\frac{M}{\varkappa}(g_1^2+3g_2^2),$$

where g_1, g_2 are the coupling constants between the vector meson field and the nucleons.

The corresponding non-relativistic cross-section is:

$$S_{NR} = \frac{p^2+M^2}{8\pi}\left\{(g_1^4+3g_2^4)\frac{10}{\varkappa^2(\varkappa^2+4p^2)} + \frac{g_1^4-3g_2^4+6g_1^2g_2^2}{p^2(\varkappa^2+2p^2)}\log\frac{\varkappa^2+4p^2}{\varkappa^2}\right\} \quad (4)$$

and it does not involve any pseudoscalar coupling constants.

Using, for example, the constants of interaction of the Møller–Rosenfeld theory, $f_1 = g_1 = 0{\cdot}62$; $f_2 = g_2 = 1{\cdot}08$, corresponding to a meson mass 286 m_e, one gets, for incident neutrons of 90 MV. (laboratory system), $S_{NR} = 13{\cdot}5 \times 10^{-26}$ cm.^{2}. The experimental value[7] is approximately 9×10^{-26} cm.^{2}. The non-relativistic cross-section, as in the usual theories, is too large. If we take into account the relativistic terms, we obtain $S = 16{\cdot}2 \times 10^{-26}$ cm.^{2}, showing a further increase in the cross-section. This result is not changed by a more exact evaluation of the cross-section in terms of the velocities of the nucleons. In order to draw more definite conclusions, however, it seems necessary to revise the usual treatment of the ground state of the deuteron by taking account of the velocity-dependent and contact interactions.

I wish to thank Prof. L. Rosenfeld for many valuable discussions, and am also indebted to the Centre National de la Recherche Scientifique for a grant which entitled me to stay at the University of Manchester.

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Meyer Analysis of Metals

Messrs. Finniston, Jones and Madsen discuss in a recent communication[1] the variation of ultimate hardness number Pu with the Meyer index n, in the ball indentation test. There are several good reasons for associating a decrease in the n value with a decrease in the work-hardening capacity of a metal, especially since n and Pu have hitherto shown a negative correlation coefficient. Finniston *et al.*, however, suggest that this generalization should be reconsidered, and they give results showing a positive correlation coefficient between Pu and n for metals of non-cubic structure and of increasing anisotropy as judged by results for thermal expansion. Their proposal is interesting because certain anomalies exist regarding the n value. Thus, during the progressive cold rolling of copper it may drop from 2·34 to 2·0 at an early stage and then remain more or less constant, while the Pu value will continue to increase and thus indicate further work-hardening[2]. This peculiarity has not been explained, and it should be remarked that the progressively rolled copper increasingly develops anisotropic properties (preferred orientation) as shown by X-ray diffraction and etching tests. This effect does not appear to be inconsistent with their proposal.

Furthermore, there is evidence that when a stainless steel 18/8 alloy is progressively cold-worked, the Pu value rises steadily while n first falls and then *rises*. During the tempering of high-carbon steel, Pu will fall progressively but n will first fall and then rise slightly. Finally, in the course of investigations with the new hardness microtesters, results are being obtained where the Meyer index to the pyramid indentation *increases* with cold working as compared with a fall in the normal ball test.

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The Geminid Meteor Shower

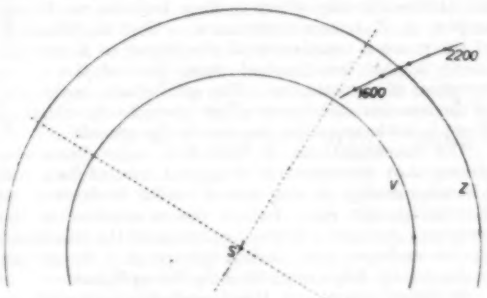
IN 1947, Whipple[1] published new elements of the Geminid meteor shower, obtained photographically. An extremely short period, 1·65 years, moderate inclination and considerable eccentricity (see below) together make the orbit of this shower an extraordinary one both in comparison with comets and with minor planets. But, according to Hoffmeister[2], the existence of similar meteor showers seems to be indicated. Such a short-period meteor shower as

the Geminids presents new aspects in meteor astronomy. Planetary perturbations are likely to play a great part in its nature. The study of secular perturbations is especially important, both in investigating the connexion with comets, and also from the observer's point of view; for example, Adams's classical work on the Leonids.

I have computed secular perturbations of the Geminids, due to Jupiter and the earth, using the Gauss–Hill method. The following table contains Whipple's elements of the Geminid orbit and their variations in a hundred years.

Elements, epoch 1937	Secular perturbations by Jupiter	Earth	Elements, epoch 1937	Secular perturbations by Jupiter	Earth
π 225° 02′	−0·1′	−1·1′	e 0·900	−0·001	0·000
Ω 260° 43′	−95·0′	−2·2′	a 1·396	—	—
i 23° 28′	+47·8′	+0·7′			

Although the earth approaches the shower very closely in its descending node, the secular perturbations due to it, owing to the small mass, are negligible compared with the effect of Jupiter. As the Geminids do not come near any other planet, perturbations caused by these are likely to be even smaller. The orbit rotates rather rapidly around the line of apsides, the direction of which remains nearly constant.



Secular motion of the descending node of the Geminid orbit on the plane of the ecliptic between the years 1600 and 2200. *V*, orbit of Venus; *Z*, orbit of earth

From the observer's point of view, the most important phenomenon is the rapid backward shift of the node. In consequence, the date of maximum activity of the shower moves backward by one day in about sixty years. Moreover (see diagram), the corresponding point of intersection of the Geminid orbit with the plane of the ecliptic does not move parallel with the earth's orbit, but cuts it at a steep angle. Consequently, the least distance of the shower from the earth changes, as the following table shows:

Year	Longitude of the node	Date of the maximum activity	Radius vector of the shower	Distance from earth
			astro. unit	
1700	264° 33′	XII 17·7	0·8503	0·1337
1900	261° 18′	14·5	0·9665	0·0178
2100	258° 03′	11·4	1·0912	−0·1066

(Data are reduced to the epoch 1950, see ref. 3.)

The Geminids first appear each year about December 1. On that date, the earth is still about 0·1 astro. unit from the centre of the shower. Let us take this distance as a limit for the visibility of the shower. Then, according to the table, the appearance of the Geminids is limited in time-range to about four centuries. They probably appeared after 1700 and will disappear again about 2100. At present, the orbits of the earth and the Geminids very nearly intersect, and consequently the shower should be of maximum intensity. Before 1700, the Geminids came nearer to Venus than to the earth.

Observations are too few to confirm these theoretical deductions. The time of maximum activity of a shower differs somewhat from the date of the earth's passage through the node. By means of a new method, I have determined the date of maximum and the position of the radiant point with sufficient accuracy. A secular backward shift of the node seems to be indicated by the observations. The secular motion of the radiant point is too small in the time-interval covered by observations for confirmation. There is, however, another striking fact: at the present time, the Geminids are, after the Perseids, the strongest steady meteoric shower. The much feebler Lyrids, for example, have been known for many centuries, while no reports about the Geminids seem to have existed before 1830. Even the nineteenth century has paid little attention to this remarkable shower. This may be partly due to bad and cold December weather, and partly to cosmic causes.

The existence of a parent comet in such a short-period orbit, even in the past, seems to be not very probable. Planetary perturbations could scarcely have reduced the semi-major axis so much. More probably, the Geminids were separated from a parabolic comet by the close approach of the comet to the sun. Malzev[4] considered the possible connexion between the Geminids and the great comet of 1680. He disproved the separation by planetary perturbations. I have fully confirmed his conclusions. Nevertheless, the orbits come near each other a little behind perihelia and in close proximity to the sun; a possible connexion cannot therefore be excluded. Investigations of the age of the shower may throw more light on the subject.

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Ratio of Total to Selective Absorption

Values of the ratio of total photographic absorption (A) to selective absorption (E) in our galaxy have been found by several investigators. Summaries of various investigations are given by Oort[1] and van Rhijn[2]. The latter adopts a mean value of $A/E_1 = 8{\cdot}2$ (where E_1 is photo-electric colour excess). For the Andromeda nebula, Stebbins and Whitford[3] find $A/E = 4{\cdot}0$.

From an analysis of star counts, the surface distribution of obscuring clouds affecting the stars of photographic magnitude 13·0 within galactic longitudes 290–360° and galactic latitudes ± 30° has been determined. Details will be published in No. 4 of a series of "Contributions from the Armagh Observatory". By comparison with the photo-electric colour excesses of Stebbins, Huffer and Whitford[4], a value has been derived for A/E.

The mean distance of stars of photographic magnitude 13·0 was taken as 1,000 parsecs. Photo-

Star counts; rel. absorption		No. of stars with colour excess	Mean dist. (parsecs)	A	E	A/E	A'/E $A' = A + 0{\cdot}4$ mag.	A'/E $A' = A + 0{\cdot}7$ mag.	A'/E $A' = A + 1{\cdot}0$ mag.
in log N	in m								
<0·09	<0·25	15	1004	0·15	0·14	1·1	3·9	6·1	8·2
0·09–0·18	0·25–0·50	12	982	0·39	0·23	1·7	3·4	4·7	6·0
0·18–0·36	0·50–1·00	38	1021	0·78	0·22	3·5	5·4	6·7	8·1
0·36–0·54	1·00–1·50	13	966	1·36	0·33	4·1	5·3	6·2	7·1
>0·54	>1·50	8	926	2·31	0·50	4·6	5·4	5·9	6·5
		Mean	995	0·85	0·25	3·4	5·0	6·2	7·4

electric colour excesses of stars between 800 and 1,200 parsecs were used, the distance-moduli being those of Stebbins, Huffer and Whitford[4]. Their colour excesses (E_1) were increased by 50 per cent to reduce them to the International System (E). The stars were grouped according to the degree of obscuration, as shown in the accompanying table.

Column 7 gives the first approximation of A/E. Its systematic dependence on A suggests a zero-point correction to the latter. This is not surprising, since the values of A were derived by assuming the absence of obscuring clouds for certain of the brightest Milky Way regions, and making no allowance for general absorption in these directions. The last three columns of the table give values of A/E on the assumption of a general absorption coefficient of 0·4, 0·7 and 1·0 mag. per kiloparsec respectively.

With an absorption coefficient of 0·7 mag./k.parsec, the systematic dependence of A/E on A disappears. A value of $A/E = 6$ would therefore be indicated from the present data.

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Effect of E-Avitaminosis on the Histiotrophic Nutrition of the Mouse Embryo

A MAMMALIAN embryo obtains its nourishment in two ways, hæmotrophically and histiotrophically. By the former is meant feeding through the placenta, the previously broken-down foodstuffs being transferred osmotically from the maternal blood-system to the embryo; the latter, on the other hand, means that nutriment is transferred, after breakdown by certain embryonic organs, to the metabolism of the embryo, by the secreting activity of the mucous membrane of the uterus.

Histiotrophic nutrition is more primitive than hæmotrophic. In the simpler placental types the nutrition of the embryo is entirely histiotrophic. As one approaches more developed placental types, hæmotrophic nutrition becomes more and more important. Histiotrophic feeding occurs, however, in combination with hæmotrophic, in all higher placental types also, at least in the earlier period of development of the embryo.

S. Pesonen showed in 1942[1] that histiotrophic nutrition plays a great part in the embryonic development of the hedgehog, and that progesterone from the corpus luteum causes the secretion of 'histiotrophe'. The chief sites of formation of histiotrophe are those parts of the mucous membrane of the uterus which lie between the embryos, and remain modified throughout pregnancy, and where thus no decidua tissue is being formed. In collaboration with Miss Kaarina Vaalanto, I have established that the mouse embryo also uses histiotrophe as its nutriment throughout pregnancy, although this mode of nutrition is not so obvious as in the hedgehog. The histiotrophe is transferred to the embryo through the decidua capsularis and yolk-sac. The secretion of histiotrophe throughout pregnancy is due to the corpus luteum remaining active during this whole period.

E-avitaminosis in a mouse results in the offspring being stillborn, in miscarriages and resorption of the embryos. Changes in the placenta seem not to be so great that they could prevent hæmotrophic feeding and so be the reason for the discontinuance of pregnancy. According to the investigations I have carried out in collaboration with Miss Elli Laine, there seems to be less histiotrophe in the uterus of pregnant E-avitaminotic mice than in that of pregnant healthy ones. It reaches its highest value, both in the E-avitaminotic and in the normal animals, on the eleventh and twelfth days. After the thirteenth day, there is very little or no histiotrophe in E-avitaminotic mice. The modification of the mucous membrane of the uterus in E-avitaminosis is also less marked than that of the endometrium of normal uteri. The epithelium, especially, of the mucous membrane is less altered. In addition, there is little secretion present in the glands.

The investigations of Miss Elli Laine have also shown that the amount of ionized iron (determined histochemically) in the uterus begins to decrease in E-avitaminotic mice before the resorption of the embryo. Just prior to the beginning of the resorption of the embryos and during this process, it appears in especially large quantities in the yolk-sac.

A fuller report of these investigations will be published later.

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Sinus Gland and Tyrosinase Activity in *Carcinus mœnas*

IT has been shown[1] that the crustacean cuticle undergoes at each moult a tanning process similar to that taking place in insects. Tyrosine and tyrosinase, which are involved in the tanning of the insect cuticle, are known to occur also in the blood of decapod Crustacea[2,3], and it is therefore of interest to discover whether as in insects there exists a neurosecretory regulatory mechanism for the control of tyrosinase activity in relation to moulting. In the blowfly larva, the oxidation of tyrosine under the influence of tyrosinase activity is modified by the low redox potential of the blood resulting from the action of a glucose dehydrogenase, itself controlled by Weismann's ring, a complex gland near the brain[4].

A study of tyrosinase activity in *Carcinus mœnas* has shown that marked variations occur in the course of the moult cycle, although the blood tyrosine remains more or less constant (0·003 per cent) at all

stages. Apart from quantitative changes in the enzyme, it appears that other limiting factors are involved in the observed fluctuations in tyrosinase activity. The redox potential of the blood shows well-marked variations in the course of the moult-cycle, being low in the middle phases of the inter-moult period and later rising before the onset of ecdysis to a value of + 0·330 V. In view of the regulatory influence of redox potentials on tyrosinase activity[5,6], it seemed probable that the feeble activity observed in the middle intermoult stage may be related to the low redox potential.

That this low potential is due to dehydrogenase activity is suggested by the increase in tyrosine oxidation on treatment of blood with methyl alcohol, which is known to have an inhibitory effect on dehydrogenases[6,7]. A study of the cyanide-insensitive respiration of the blood and soft parts of *Carcinus* suggests the presence of a dehydrogenase system which is most active in the middle intermoult stages and declines some time before the moult, after which it again shows a rise. The periods of rise and fall of cyanide-insensitive respiration, later referred to as dehydrogenase activity, correspond with the variations in tyrosine oxidation.

In the light of recent observations on the sinus gland of decapod Crustacea and the hormonal regulation exercised[8–12] on moulting and associated events, such as calcium resorption from the exoskeleton, changes in water content and oxidative metabolism, it was of interest to find that dehydrogenase and tyrosinase activity appear to be controlled by the sinus gland. The effect of injecting saline extracts of eye-stalks of *Carcinus mœnas* into animals in different stages of the moult-cycle is to raise dehydrogenase values and correspondingly to reduce tyrosine oxidation. Removal of the sinus glands by eye-stalk extirpation has a marked effect on the dehydrogenase system; but one which seems, however, to depend on the stage in the moult cycle in which the operation is carried out. In the hard-crab stage, the effects are well marked, resulting in an initial fall in dehydrogenase activity followed by a rise until moulting occurs. Comparison of dehydrogenase activity in normal and operated animals of the same size and stage in the moult-cycle shows in the latter a shortening of the periods of rise and fall in the dehydrogenase cycle. This corresponds with the abbreviation of the intermoult period effected by removal of the sinus gland[13,14,15]. It appears, therefore, that the sinus gland influences dehydrogenase activity as a part of the physiological system associated with moulting.

A full account of this work will be published elsewhere.

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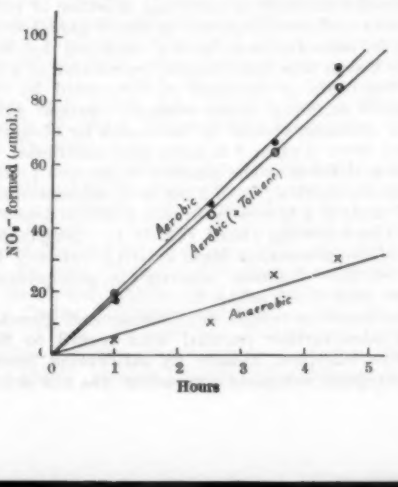
Enzymic Decomposition of Nitromethane by Liver Homogenates

SINCE nitro-compounds of biological origin have not long been recognized, little is known of their metabolism apart from some pharmacological investigations. Recent biochemical work, however, has revealed for the first time the presence of a nitro-group in the molecule of a microbial product, chloromycetin. Hence it is of considerable interest to study enzymic reactions involving nitro-compounds.

In the course of a study of the hepatic reduction of nitrate[1], we have observed the enzymic decomposition of nitromethane by rabbit liver homogenates to form nitrite ion as one of the products. This seems to be of significance as the first indication of the existence of an enzyme system which splits off nitro-groups from organic molecules. The present communication gives a brief report on our observations.

Fresh rabbit liver was homogenized with five volumes of distilled water in a Potter–Elvehjem homogenizer. 1-vol. portions of homogenate were incubated at 37° with 2 vol. of 0·05 *M* nitromethane in phosphate buffer (0·1 *M*, *p*H 7·4); 0·1 vol. of toluene was added occasionally to prevent contamination by bacteria, especially when incubation extended over a long period of time. The addition of toluene showed scarcely any influence upon the process. After suitable intervals the reaction mixtures were deproteinized, and the nitrite formed was determined colorimetrically with a Pulfrich stufen-photometer using Griess–Ilosvay reagent. The incubations were carried out both aerobically and anaerobically. Thunberg tubes were employed in the anaerobic experiments.

In the accompanying graph typical results thus obtained are shown. It will be seen that nitrite can be produced both in the presence and absence of oxygen, but aerobic decomposition takes place more rapidly. Nitrite formation was completely inhibited by heating the homogenates at 100° for 3 min. This fact may be considered to be evidence of the enzymic nature of the reaction. Further, it was found that the dialysis of the homogenates against standing water for 24 hr. at 1° decreased the activity to about 40 per cent of the original value, but it could be restored by the addition of boiled extracts of the liver. This seems to indicate that two components are necessary for the decomposition of nitromethane, one of which is thermolabile and colloidal, whereas the other is thermostable and of low molecular weight. No other decomposition product of nitromethane,



apart from nitrite ion, has yet been confirmed. Formaldehyde, one of the possible products, was not detected (Schiff's reagent) in the distillates of the reaction mixtures (concentrated hydrochloric acid was added to a final concentration of 20 per cent before distillation).

Heppel and Porterfield[2] have reported that rat liver homogenates can oxidize nitrite aerobically to nitrate. We have also confirmed this fact in beef liver homogenates; but the oxidation of nitrite by rabbit liver homogenates has been found to be negligible compared with the formation of nitrite from nitromethane.

Details of the experiments will be described elsewhere.

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Enzymic Inactivation of Serum Gonadotrophin

THE recent reports by Whitten[1] and Friedmann[2] that a partially purified *Clostridium welchii* culture filtrate contains one or more substances which inactivate serum gonadotrophin, and that one of the factors responsible may possibly be identified with the enzyme destroying blood-group O substance, prompts us to record some results obtained by us at the National Institute for Medical Research during 1943–45 on the action of taka-diastase upon serum and chorionic gonadotrophins.

Evans and Hauschildt[3] found preparations of serum gonadotrophin to suffer loss of activity when incubated with proteolytic or carbohydrate-splitting enzymes, including taka-diastase, and drew the conclusion that both the carbohydrate and protein portions of the molecule are essential for the activity of the hormone. They clearly assumed, without further experimental support, that the inactivating power of taka-diastase was due to its amylolytic enzyme. One of us[4] has reported the presence in taka-diastase of N-acetylglucosaminidase (with optimal *p*H 6·5), and it seemed necessary to ascertain whether or not this enzyme could inactivate mares' serum gonadotrophin.

Crude taka-diastase, kindly supplied by Messrs. Parke Davis, was fractionated by ethanol at *p*H 4·8, and the units of diastase (*d*, estimated by Wohlgemuth's achromic point method, optimal *p*H 5·2) and of glucosaminidase (φ, estimated by liberation of phenol from β-phenyl-N-acetylglucosaminide, where 1 unit is defined as the amount of enzyme producing 50 per cent hydrolysis of 2 mgm. of substrate in 1 hr. at 37° and *p*H 6·5) present in each fraction determined, with the following result (Table 1). Nearly 60 per cent of the glucosaminidase activity but only 10 per cent of the diastatic activity is precipitated by 45 per cent (v/v) ethanol.

The fractions containing diastase and glucosaminidase were further purified with regard to the respective enzymes, mainly by adsorption processes, and although complete separation was not achieved,

Table 1. FRACTIONATION OF CRUDE TAKA-DIASTASE BY ETHANOL AT *p*H 4·8

Ethanol % (v/v)	Wt. ppt. (gm.)	N-acetyl-glucosaminidase (φ) units	Diastase (*d*) units	φ/*d*
Starting material	50	2,000,000	20,000,000	0·1
0–45	8·560	1,176,000	2,000,000	0·6
45% insol.*	6·3			
45–50	4·305	709,200	3,333,333	0·2
50–55	9·385	56,800	12,000,000	0·005
55–60	3·675	nil	600,000	—
60–66	3·310	nil	33,333	—
M. liq.	13·113	nil	2,500	—
Total	48·648	1,942,000	17,969,166	

* Material which did not redissolve in water: mainly inorganic.

the amount of diastase still present in the glucosaminidase was reduced more than a thousandfold. Such a preparation produced no significant inactivation of serum gonadotrophin, whereas crude taka-diastase containing the same unitage brought about a 66 per cent inactivation in the same time under identical conditions (see Table 2). Glucosaminidase could therefore be excluded as a possible inactivator of mares' serum gonadotrophin. The diastase fraction, when similarly tested, brought about 19 per cent inactivation as compared with 81 per cent in the crude material. Still further purification by electrophoresis provided a very active diastase, but which was completely without action on the gonadotrophin even when tested at eighteen times the unitage and for three times the duration which sufficed for the crude material (Table 2). The enzyme responsible for the inactivation of gonadotrophin is not, therefore, the diastase. The possibility of its being a protease or simple peptidase was excluded by tests using gelatin or leucyl–glycine as substrate, and by examining for any increase in titratable carboxyl-groups during the inactivation of mares' serum gonadotrophin by taka-diastase.

An attempt to define the nature of the inactivating enzyme was next made by studying the products of its reaction with mares' serum gonadotrophin; but difficulty was encountered owing to the fact that gonadotrophin preparations had to be used that were known to be not more than 20 per cent pure. Nevertheless, it was shown that inactivation is accompanied by the liberation of some material which passes through a 6-mμ 'Gradocol' membrane in ultrafiltration, and which contains carbohydrate determinable by the orcinol or Hagedorn and Jensen methods. The quantity by either method amounted to about 6·5–7·5 per cent of the total carbohydrate of the mares' serum gonadotrophin preparation.

Table 2. INACTIVATION OF GONADOTROPHIN BY PURIFIED TAKA-DIASTASE FRACTIONS

Fraction	*p*H	Added to 3·3 mgm. mares' serum gonadotrophin (7,000 I.U.)			% inactivation in 1 hr. at 37°
		Dry wt. (mgm.)	Units (*d*)	Units (φ)	
Crude takadiastase	5·2	0·94	1,500	150	81·4
" "	6·5	0·94	1,500	150	65·7
" " (heated)	5·7	0·94	1,500	150	0
Diastase	5·2	0·47	1,500	4·5	18·6
Diastase (electrophoretic)	5·2	1·12	28,700	200	0 (in 3 hr.)
N-acetyl-glucosaminidase	6·5	0·23	1·25	150	1·7

The enzyme was largely inhibited by addition of certain metal co-ordinating substances, α-methyl-α-hydroxy butyrate being found most effective in this respect.

Chorionic gonadotrophin is similarly inactivated by crude taka-diastase.

A study has also been made of the action of 0·05 *N* sodium carbonate at 100° for 6 min.[5] upon serum and urinary gonadotrophin preparations, and upon the carbohydrate-rich fractions of normal horse serum[6]. This treatment liberated about 40 per cent of the total N-acetylglucosamine from the mares' serum and human chorionic gonadotrophins. The proportion of their N-acetylglucosamine liberated from the serum albumin fractions varies from 0 to 90 per cent, and is related to the concentration of ammonium sulphate required for their precipitation. Thus fractions precipitated by 50, 60 and 66 per cent saturation yielded 0, 64·5 and 90 per cent of their N-acetylglucosamine contents respectively. The interpretation of the reaction with impure gonadotrophin preparations is therefore difficult.

The investigations referred to in this letter are being taken up once more, and, in particular, the purification of the gonadotrophin-inactivating enzyme in taka-diastase.

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Amino-acids in Soil

Although the protein nature of at least one-third of the organic nitrogen of soil has been established[1,2], very little is known of the amino-acid composition of this protein material. The isolation of amino-acids from soil hydrolysates is rendered difficult by the presence of large amounts of extraneous inorganic and organic material.

The present communication gives preliminary results of an examination of the amino-acid composition of soil hydrolysates by the paper chromatography technique[3]. The soils were hydrolysed for 24 hr. with 6*N*-hydrochloric acid and the hydrolysates evaporated to dryness *in vacuo*, redissolved in a little distilled water, neutralized and desalted on the apparatus devised by Consden, Gordon and Martin[4]. The experimental procedure used for two dimensional chromatography was essentially that of Dent[5], phenol and a collidine–lutidine mixture being used as solvents. The soils examined included several highly organic neutral soils from the Fens and neutral mineral soils from Rothamsted plots. The following amino-acids have been identified in the hydrolysates of these soils: aspartic and glutamic acids, serine, threonine, glycine, alanine, valine, leucine, *iso*leucine, proline, hydroxyproline, arginine, histidine, lysine, phenylalanine, tyrosine, β-alanine, α-amino-*n*-butyric acid and γ-aminobutyric acid. In addition, glucosamine and two as yet unidentified substances giving purple colours with ninhydrin have been detected. The latter occupy positions under glutamic acid and under proline on the two-dimensional chromatogram. Attempts are now being made to identify these substances.

The amino-acid composition of the protein material appeared to be substantially the same over the range of soils so far examined. No free amino-acids have been detected in any of the soils studied.

Full details of this work will be published elsewhere.

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Occurrence of Pterin Pigments in Hymenoptera

It has been found that pterins exist in tissues of animals belonging to nearly all groups; their occurrence as pigments, however, is restricted to insects and cold-blooded vertebrates[1,2]. Among Lepidoptera, they are always present in the wing-scales of the Pieridæ and appear to be a biochemical characteristic of that natural family[3,4]. Becker and Schöpf[3] and Becker[4] also found pterins in the integument of Hymenoptera and gave evidence of their wide distribution within this order.

In 1947, E. B. Ford[4] described a new 'murexide test' for the recognition of pterin pigments in the wings of intact butterflies. This consists in exposing specimens to chlorine and then fuming with ammonia. Following this treatment, pterin pigments develop a brilliant purple colour. We have applied this method successfully to the pterins of the exoskeleton of Hymenoptera.

The yellow and yellowish spots of adult Hymenoptera give the reaction. One exception only was recorded: the yellow of *Urocerus gigas* L. (Siricidæ) seems to be due to light melanin and not to pterins.

Hymenoptera show, therefore, a striking difference in that respect from Lepidoptera. Pterins are found as pigments among Symphyta, parasitic and aculeate Hymenoptera, in primitive as well as in highly specialized groups. There is scarcely any family which shows pterin pigments in all its representatives; but there are several tribes and generic entities which do so (Philanthinæ, Bembecinæ, *Crabro*, *Ectemnius*, *Lestica*, *Odynerus*, etc.). Moreover, a large number of families and genera are entirely devoid of pterin pigments (Siricidæ, Trigonalidæ, Formicidæ, Chrysididæ, Pseninæ, etc.).

Preliminary conclusions can also be drawn suggesting relationships between the occurrence of pterins in the integument and geographical and morphological features. Groups mostly distributed in the northern hemisphere often have large spots of yellow pterin pigment (Pamphiliidæ, Cephidæ, Tenthredininæ, Metopiinæ, Ichneumoninæ, Crabroninæ of the genera *Crabro*, *Ectemnius* and *Lestica*; Vespidæ of the genera *Vespa*, *Pterochilus*, *Psiloglossa*, *Celonites*, *Jugurthia* and the parasitic bees *Nomada*). On the other hand, groups mostly distributed in the

southern hemisphere and in the tropical regions are often devoid of yellow spots (Arginæ, Aulacidæ, Trigonalidæ, Stephanidæ, Evaniidæ, Pelecinidæ, Trypoxyloninæ and Vespidæ of the genera *Zethus*, *Montezumia*, *Icaria*, *Polybia*, etc.). Among aculeate Hymenoptera, the genera with strongly petiolated first abdominal segment are usually without yellow spots; whereas it can be said tentatively that the Sphecidæ and Vespidæ with bright yellow spots on the abdomen should be generally referred to forms with sessile first abdominal segments.

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Quadruple Structure of the Centromere

PRE-TREATMENT with 8-oxyquinoline (0·002 mol. per litre for four hours) of root meristems followed by squashing in acetic orcein gives chromosome pictures of exceptional clearness. The chromosomes are contracted as after cold or *c*-mitotic treatment. At the same time the metaphase chromosomes remain in their original position within the equatorial plate, although the spindle does not interfere with their spreading at the squashing. Satellites and secondary constrictions are conspicuous, and help the analysis of idiograms. Prophase chromosomes often show heterochromatic differentiations. The knobs of rye chromosomes are made quite conspicuous in mitotic prophase.

The centromeric gap is unusually wide, and it often exhibits distinct centromeric chromomeres. From early prophase up to metaphase there are found four such centromeric chromomeres, generally forming a square or a parallelogram in the centromeric gap. The accompanying figures (*a*) and (*b*) show this condition in *Allium cepa* and *Scilla sibirica* respectively. At anaphase and telophase only two centromeric chromomeres are seen, their division not yet having been accomplished.

One chromosome (*a*) of *Allium cepa* (at three different foci), and (*b*) of *Scilla sibirica* (drawing and microphotograph)

The type of structure described here has been demonstrated with our technique in species of the following genera: *Tradescantia*, *Scilla*, *Lachenalia*, *Hyacinthus*, *Allium*, *Sauromatum*, *Amorphophallus*, *Hæmanthus*, *Vallota*, *Amaryllis*, *Crinum*, *Cyrtanthus*, *Nerine*, *Hordeum*, *Secale*, *Triticum*, *Triticale*, *Vicia*. There seems to be a correlation in size between the chromosomes and their centromeric bodies; thus, the centromeric chromomeres were largest in *Scilla*, smaller in *Allium* and *Hordeum*. In species with small chromosomes we have so far been unable to detect any centromeric bodies, possibly because the chromosome contraction effected in such chromosomes is too strong. Thus *Vicia faba* presented centromeric bodies, whereas *Vicia cracca* with its much smaller chromosomes did not.

The results mentioned here give a new aspect to the view of the centromeric apparatus as a structure that is doubled in the longitudinal direction, earlier demonstrated with other techniques by Östergren[1], Lima de Faria[2] and Levan[3].

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Colour-Contrast Phase Microscopy

THE possibilities of utilizing the differential chromatic effects of the Rheinberg ring method of illumination, which was later developed into the optical staining principles of Kraft[1], in conjunction with phase-contrast microscopy, suggested that, instead of having the substage stop quite blacked out except for the annulus, cross or line, whichever the case may be, this should be replaced by an appropriate colour filter, and the portion which usually transmits the light be of another colour in contrast to it.

A number of combinations have been tried with the materials available to date and the best results were secured with the following:

	Transmitting area, annulus, cross or line	Substage field filter, usually blacked out
1	Yellow	Blue
2	Yellow	Purple
3	Green (light)	Purple
4	Blue (light)	Red
	also used with success:	
5	Clear glass	Blue
6	Clear glass	Purple

The Wratten series of filters have been used, and with those available the best results obtained have been in the order given above. It is essential that all filters should have sharp absorption curves, so that too much chromatic overlapping is avoided. The image, that is the portion usually appearing black in ordinary monochromatic phase-contrast, assumes in each case the colour of the filter appearing in the second column, the phase 'halo' being that of the

normal transmitting area, and the more distant portions of the clear field being of an intermediate shade. The substage 'field' portion must always be less bright visually than the transmitting area, and a valuable method of varying the intensity of the image contrast is to mount portions of 'Polaroid' over the field areas of this plate, and decrease or increase the intensity by rotating a 'Polaroid' screen in an understage filter carrier. In this case, as the crossed position was approached, the image assumed the characteristics of normal monochromatic phase-contrast, excepting that the field of view in the microscope took the colour of the transmitting portion. Further useful contrast effects may be obtained by placing an appropriate filter over the ocular of the microscope.

This method has been used with success on difficult sections of neurological material prepared by the Feulgen Light-Green technique[2] mounted in fluid or 'Euparal', and it greatly facilitates the examination of all faintly stained or coloured slides when suitably mounted. Contrast is obtained by virtue of the slight colour differences of fine detail not revealed by normal phase-contrast or ordinary light filters. The examination of insect parts is facilitated, and many applications will no doubt arise in the normal course of research.

It is a pleasure to record my indebtedness to Mr. M. G. L. Curties, of Messrs. C. Baker, London, W.C.1, whose assistance so readily given made this research possible.

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Preparation of Acetobrome-Sugars

THE preparation of acetobrome-sugars involves generally the use of hydrogen bromide dissolved in glacial acetic acid or acetic anhydride. These solutions are very disagreeable to handle and to prepare; we therefore tried to circumvent their use, and after some preliminary experiments found a really satisfactory way of doing so.

We found that perchloric acid is a very efficient catalyst in acetylation[1-4], as described by several authors. We did not find it necessary, however, to use a mixture of acetic anhydride and glacial acetic acid; the method works perfectly with acetic anhydride alone. The essential feature of our procedure is to generate hydrogen bromide within the reaction mixture. To do this we either added phosphorus tribromide and water to the mixture, or simply added phosphorus, bromine and water one after the other. The minimal amounts and reaction times necessary to accomplish the reaction were determined in a series of experiments.

We prepare acetobrome-glucose as follows: 400 ml. acetic anhydride is mixed with 2·4 ml. perchloric acid, and 100 gm. glucose is added in the course of half an hour, taking care that the temperature should not rise unnecessarily above 40° C. (to avoid caramellization) or fall below 30° C. (to keep up a steady rate of reaction). 30 gm. amorphous phosphorus is added and the vessel is cooled in ice or an ice–salt mixture. We then add 180 gm. bromine gradually so as to keep the temperature below 20° C., and proceed directly to add 90 per cent of the stoichiometric amount of water, that is, 36 ml., carefully avoiding local rises of the internal temperature. This latter process takes about half an hour. The vessel is closed by a stopper and remains at room temperature for 1½–2 hr. Then 300 ml. chloroform is added and the mixture is poured into about 800 ml. ice-water and separated in a funnel. The chloroform layer occludes the rest of the phosphorus, and it is convenient to separate it at this stage by filtration. The filtered chloroform is extracted twice with an equal volume of ice water, taking care to extract the separated water twice with 30 ml. chloroform before discarding it. A final extraction with sodium bicarbonate solution in the separating funnel binds the last traces of acid and brings the *p*H to about 6. The yellow solution is dried with calcium chloride, adding a small amount of sodium bicarbonate, calcium carbonate or magnesium carbonate and about 5 gm. active charcoal with slight agitation. After half an hour the solution is filtered, evaporated *in vacuo* from a water-bath at 60° C. and dissolved in its own volume of dry ether, from which it crystallizes on cooling. Addition of double the volume of petrol-ether assures an improved yield. The product melts at 84° C. and is practically pure acetobrome-glucose. It may be used directly for further synthesis. Yield: 85 per cent; recrystallization from ether gives a melting point of 87° C.

We prepared the acetobrome derivatives of galactose, arabinose, lactose, cellobiose and maltose by the same method. It was necessary to use some glacial acetic acid for the acetylation of cellobiose, due to its poor solubility; and we only succeeded in obtaining a crystalline product from galactose when we dissolved the syrup in absolute ether. The syrup of bromacetomaltose turned into a white powder on addition of ligroin (b.p. 80–100° C.) with the somewhat uncertain melting point of 78° C. instead of 84° C., but contained the theoretical percentage of bromine. Rhamnose, a sugar that is not easily acetobrominated except with titanium tetrabromide, yielded a syrup which we were not able to crystallize. Yields before recrystallizing were: lactose 85 per cent, arabinose 50 per cent, maltose 60 per cent, cellobiose 72 per cent, galactose 75 per cent.

The whole procedure is easily finished in a working day of eight hours, exclusive of recrystallization. The products are very pure and may be kept in a vacuum desiccator for weeks without decomposition. We think that the above method may be extended to similar compounds and represents the simplest way of obtaining them.

We are indebted to Prof. Z. Csűrös for permission to work in his laboratory, and are grateful to him as well as to Prof. R. Bognár for their advice. One of us (F. K.) has a grant from the Hungarian Council of Science.

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Difference Equations of Moment-Generating Functions for some Probability Distributions

Wishart and Hirschfeld[1] obtained the moment-generating function for the probability distribution of adjacent black-white joins when m points, black or white with probabilities p and q, are arranged at random on a line, by working out the difference equations connecting the moment-generating functions for $(m-1)$, m and $(m+1)$ points. Recently, Krishna Iyer[2] used this method to derive the moment-generating function for the distribution of black-black joins. The success of the method depends upon the fact that the r-th factorial moment, $\mu'_{[r]}$, is equal to $r!$ multiplied by the expectation for obtaining r black-black joins. This property will enable us to work out the difference equations satisfied by the moment-generating functions of a number of distributions arising from m points arranged at random on a line. This note gives *in seriatim* the difference equations for the following distributions: (i) the number of joins between points of different colours when the points can assume one of k colours with probabilities $p_1, p_2 \ldots p_k$, (ii) the number of runs of length r of a specified colour, (iii) the number of runs of length r or more of a specified colour, and (iv) the number of triplets, quadruplets, etc., of a specified colour. They are as follow:

$$\text{(i)}\quad M_m - M_{m-1} - 2a_2\theta M_{m-2} - \sum_{r=2}^{k} (r-1)a_r\theta^r M_{m-r} = 0,$$

where a_r stands for the monomial symmetric function of degree r in $p_1, p_2, \ldots p_k$, that is, $(\Sigma\, p_1p_2 \ldots p_r)$.

$$\text{(ii)}\quad M_{m+r+1} - M_{m+r} - p^rq\theta M_m + p^{r+1}q\theta M_{m-1} = 0.$$

$$\text{(iii)}\quad M_{m+r+1} - M_{m+r} - p^rq\theta M_m = 0.$$

$$\text{(iv)}\quad M_{m+1} - (1+p\theta)M_m + pq\theta \sum_{r=1}^{s-1} p^{r-1} M_{m-r} = 0,$$

where s is the number of points in the s-plet.

In the above expressions, p is the probability of a point taking the specified colour, and $q = 1 - p$, while θ and M_m stand respectively for $(e^t - 1)$ and the moment-generating function for m points.

By extending the methods already used by me[2], it can be shown that the cumulants of all these distributions are linear functions in m, the number of points on the line, and therefore all these distributions tend to the normal form when m tends to infinity. Details will be published shortly in the *Journal of the Indian Society of Agricultural Statistics*.

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[2] Krishna Iyer, P. V., *J. Ind. Soc. Agric. Stat.*, **1**, 171 (1948).

Sulphanilamide as a Preservative for Sweet Juices from Palm Trees

The sweet juices from palm trees (date, brab, cocoanut and sago) which grow abundantly in the tropics are collected for toddy (fermented juice) or for conversion into liquor. The fresh juice is found to contain about 10–14 per cent of sucrose and could be a useful source of sugar, thus replacing cane sugar and releasing fertile land for cereals.

Palm juice is fermented very quickly; to prevent inversion and fermentation while the juice is being collected, the usual practice is to add a small amount of lime to the pots. This lime does not prevent inversion and, later on, the juice is fermented. Work carried out at this Institute has shown that palm juice is slightly acid (*p*H about 6) when fresh, but it soon becomes acid (*p*H about 4), and then is fermented to produce toddy by airborne bacteria. Experiments have shown that the juice can remain fresh and unfermented for a few hours if it is kept alkaline (above *p*H 8); in order to preserve palm juice from inversion and fermentation, so as to convert it into either gur or sugar, a preservative is needed. It has been found that sulphanilamide, when added to palm juice in quantities 10–60 p.p.m. (40–250 mgm. to a gallon), preserves the juice in its fresh condition from five to twenty days.

D. G. Walawalkar

Indian Institute of Sugar Technology,
Kanpur, U.P.
Oct. 8.

Rapid Estimation of Standard Deviation

A simple graphical method of calculating standard deviations has been described by Dr. B. Woolf[1]. It is sometimes useful, as a means of estimating short-term variations in a process or product, as distinct from long-term trends, to measure the root-mean-square of the differences between each reading and the next, a quantity which, in the absence of any trends, would be expected to have a value $\sqrt{2}\,\sigma$. A modification of Woolf's method enables this to be measured even more simply than the standard deviation.

As in Woolf's method, the various readings (in chronological order, A_1, A_2, etc.) are marked off on a line at one side of a piece of graph paper. With dividers a length A_2P_2 is then marked off equal to A_2A_1 on a line perpendicular to A_2A_1. Then $A_2P_2 = |a_1 - a_2|$. The point of the dividers is then moved from A_2 to A_3 and A_3P_3 is marked off perpendicular to A_1A_3 so that $A_3P_3 = A_3P_3 = \{(a_1 - a_2)^2 + (a_2 - a_3)^2\}^{1/2}$. By repetition of the process, moving the points of the dividers alternately, the square root of the sum of squares of differences can be found very rapidly.

Obviously, if the points have already been plotted on a control chart, there is no need to mark off the points A_1, etc.

A. Marriage

Research Laboratory,
Kodak, Ltd.,
Wealdstone,
Middlesex.

[1] *Nature*, **164**, 360 (1949).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 6

ROYAL GEOGRAPHICAL SOCIETY (joint meeting with the SYSTEMATICS ASSOCIATION, at 1 Kensington Gore, London, S.W.7), at 2.30 p.m.—Symposium on "The Cartographical Presentation of Biological Distributions".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in Room A.3, Zoology Department, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Place of High-Frequency Heating in Industry" (to be opened by Mr. C. E. Eadon-Clarke).

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. E. Doré: "Oxygen and other Gases and their Application to Industry".

INSTITUTION OF ELECTRICAL ENGINEERS, MERSEY AND NORTH WALES CENTRE (at the Liverpool Royal Institution, Colquitt Street, Liverpool), at 6.30 p.m.—Discussion on "The M.K.S. System of Units" (to be opened by Dr. E. Bradshaw).

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Dr. S. T. Henderson and Dr. J. W. Strange: "Recent Developments in Fluorescent Materials".

CHEMICAL SOCIETY, EIRE SECTION (joint meeting with the IRISH CHEMICAL ASSOCIATION, the ROYAL INSTITUTE OF CHEMISTRY, and the SOCIETY OF CHEMICAL INDUSTRY, in the Chemical Laboratories, University College, Galway), at 7.45 p.m.—Prof. M. Stacey: "Deoxy-Sugars and Nucleic Acids".

Tuesday, March 7

CHEMICAL SOCIETY, LIVERPOOL SECTION (in the Chemistry Department, The University, Liverpool), at 4.30 p.m.—Prof. Dr. Pl. A. Plattner (Zurich): "Lycomarasmin, the Chemistry of Wilting Diseases".

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. A. E. Margolis: "District Heating in the New Towns".*

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting of the MEASUREMENTS and RADIO SECTIONS, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. F. C. Williams and Mr. S. W. Noble: "The Fundamental Limitations of Second-Harmonic Type of Magnetic Modulator as applied to the Amplification of Small D.C. Signals"; Mr. A. G. Milnes: "A New Theory of the Magnetic Amplifier".

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Rev. J. L. Wilson: "Glimpses of Malaya".

INSTITUTION OF WORKS MANAGERS, LONDON BRANCH (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6.45 p.m.—Mr. J. Hadland: "The Application of High-speed Photographic Techniques to Industrial Problems".

Wednesday, March 8

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Prof. M. L. Oliphant, F.R.S.: "The Industrial Applications of Atomic Energy".

ASLIB (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. F. C. Francis: "The British National Bibliography"; Mr. W. Cox: "Government Publications, with Special Reference to the Card Index Service".

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Prof. H. Hausen (Hanover): "Heat Exchange and Rectification in Reflux Condensers".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (in the Zoology Lecture Theatre, The University, Reading), at 6.45 p.m.—Dr. G. W. Scott Blair: "Recent Advances in Rheology".

CHEMICAL SOCIETY, EIRE SECTION (in the Department of Chemistry, Trinity College, Dublin), at 7.45 p.m.—Prof. Dr. Pl. A. Plattner (Zurich): "Lycomarasmin, the Chemistry of Wilting Diseases".

Thursday, March 9

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 10 a.m.—Discussion on "Bond Energies and Bond Lengths" (to be opened by Prof. M. G. Evans, F.R.S.).

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "Time Rates in Evolution" (to be opened by Prof. F. E. Zeuner and Prof. James Small).

ROYAL SOCIETY OF ARTS, INDIA, PAKISTAN AND BURMA SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. E. V. Parkinson: "The Growth of the Steel Industry in India".

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. H. K. Bourne and Mr. E. J. G. Beeson: "The Application of Electric Discharge Lamps for Daylight Signalling".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. B. Rensch (Münster): "Problems of Directed Evolution".*

CHEMICAL SOCIETY, MANCHESTER SECTION (in the Chemistry Department, The University, Manchester), at 6.30 p.m.—Prof. J. W. Cook, F.R.S.: "Polycyclic Aromatic Hydrocarbons".

CHEMICAL SOCIETY, NOTTINGHAM SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Nottingham), at 6.30 p.m.—Prof. W. Wardlaw: "Some Aspects of Structural Chemistry".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (joint meeting with the WEST HAM MUNICIPAL COLLEGE CHEMICAL RESEARCH CLUB, at the West Ham Municipal College, Romford Road, London, E.15), at 7 p.m.—Dr. F. M. Hamer: "Photographic Sensitisers".

CHEMICAL SOCIETY, ABERDEEN SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Chemistry Department, Marischal College, Aberdeen), at 7.30 p.m.—Prof. H. B. Nisbet: "The Chemistry of Anæsthetics".

INSTITUTION OF THE RUBBER INDUSTRY, LEICESTER SECTION (at the Bell Hotel, Leicester), at 7.30 p.m.—Mr. W. P. Fletcher: "Engineering with High Polymers".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Dr. J. O. Irwin: "Statistics and Biological Assay".

Friday, March 10

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

BEDSON CLUB (in Lecture Theatre 1, Chemistry Department, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Prof. R. D. Haworth, F.R.S.: "The Natural Products of the Cycloheptane Group" (Seventy-seventh Bedson Lecture).

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. J. H. Taylor: "The Contribution of Petrology to the Study of Sedimentation" (Inaugural Lecture).*

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. B. Rensch: "Histological Changes correlated with Changes in Body Size".*

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "A Demonstration Mercury-Arc Rectifier" (to be opened by Mr. A. M. Hodgson and Prof. G. F. Nicholson).

INSTITUTION OF ELECTRONICS, NORTH-WESTERN BRANCH (at the Gas Showrooms, Town Hall, Manchester), at 6.30 p.m.—Mr. T. M. C. Lance: "Improvements in Large Screen Television".

INSTITUTION OF WORKS MANAGERS, MANCHESTER BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. Philip H. Briggs: "The Application of Electronics in Industry".

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. G. A. Campbell: "Dispersion and Wetting in Non-Aqueous Media".

CHEMICAL SOCIETY, GLASGOW SECTION (joint meeting with LOCAL CHEMICAL SOCIETIES, in the Chemistry Department, The University, Glasgow), at 7.15 p.m.—Dr. A. H. Cook: "Purine Synthesis, a New Chapter".

CHEMICAL SOCIETY, NORTHERN IRELAND SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Agricultural Lecture Theatre, Elmwood Avenue, Belfast), at 7.30 p.m.—Mr. R. A. Wells: "Inorganic Chromatography".

Saturday, March 11

SOCIETY OF LEATHER TRADES CHEMISTS, MANCHESTER GROUP (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. J. N. Blake: "The Use of Hide Trimmings by the Gelatine Manufacturer"; Mr. Charles Higham: "Hair, its Washing and Subsequent Uses".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mrs. Mercedes Mackay: "Primitive Musical Instruments of Nigeria".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT (with a Fuel, Engineering or Chemical Engineering degree or equivalent qualifications) to the Fuel Technologist (Ref. AE/48), and an ASSISTANT (with a good Honours degree in Chemistry or Chemical Engineering or A.R.I.C. by examination or A.M.I.Chem.E.) to the Scientific Adviser (Ref. AE/49), in the Generation Operation Branch of the Chief Engineer's Department at headquarters in London—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting the appropriate Ref. No. (March 10).

LECTURER (Grade II) IN INDUSTRIAL METALLURGY—The Secretary, The University, Birmingham 3 (March 18).

PRINCIPAL SCIENTIFIC OFFICER (Ref. C.70/50A), mechanical or aero engineer with experience in aircraft structures and engineering installations, SENIOR SCIENTIFIC OFFICERS (Ref. A.24/50A), physicists for research with new armament test methods, including problems on bombsighting, gunsighting, gunblast and recoil, SENIOR SCIENTIFIC OFFICER (Ref. C.71/50A), aero engineer with interest in helicopters for work connected with performance testing of rotary wing aircraft, SCIENTIFIC OFFICERS (Ref. A.25/50A), applied mathematicians for general analytical work to assist S.S.O. (Physicist) above, SCIENTIFIC OFFICER (Ref. C.72/50A), mechanical or aero engineer for flight test work and investigations into engineering problems associated with high altitude flying, at Ministry of Supply Aircraft Experimental Establishments in Southern England—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (March 20).

EXPERIMENTAL OFFICERS at Ministry of Supply Radiochemical Centre, Amersham, Bucks., for duties connected with production, processing and distribution of radioactive materials—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.111/50A (March 25).

EXPERIMENTAL OFFICERS (2, temporary) in the Pest Infestation Laboratory, London Road, Slough (*a*, Chemist for work on the application of fumigants to stored foodstuffs; *b*, Biochemist for research on the reaction of fumigants with biological materials such as proteins, vitamins, enzymes, etc.)—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.122/50A (March 25).

LECTURER IN AGRICULTURE, and a LECTURER IN HORTICULTURE—The Secretary for Education, County Buildings, Shrewsbury (March 25).

RESEARCH OFFICER (with University degree in science with physics and/or chemistry as major subjects or equivalent qualifications) in the Chemical Physics Section, Division of Industrial Chemistry, Melbourne, to carry out research in the application of electron diffraction to structural problems—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 2723 (March 25).

SCIENTISTS, Grade III (with first or second class honours in physics, chemistry or engineering, or equivalent qualification) at the Central Research Establishment at Stoke Orchard, near Cheltenham—The National Coal Board, Establishments Branch (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/194 (March 27).

DEMONSTRATOR IN BIOCHEMISTRY AND CHEMISTRY (with particular interest and training in Physical Chemistry)—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (March 31).

DEMONSTRATOR (with good honours degree in physiology, biochemistry or chemistry with subsidiary physiology) IN PHYSIOLOGICAL CHEMISTRY—The Registrar, The University, Manchester 13 (March 31).

LECTURER (Grade II) IN MECHANICAL ENGINEERING—The Secretary, The University, Birmingham 3 (March 31).

SCIENTIFIC OFFICERS (with good honours degree or equivalent in mathematics, physics or engineering, and experimental experience) and EXPERIMENTAL OFFICERS (with at least Higher School Certificate or equivalent), at Royal Aircraft Establishment, Farnborough, for work on design and development of large wind tunnels and associated aerodynamic research equipment—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.30/50A (March 31).

BIOCHEMISTS with special interest and experience in protein chemistry, to undertake research on plasma fractionation and to develop the large-scale production of plasma protein fractions at Edinburgh—The Secretary, Scottish National Blood Transfusion Association, 10 Duke Street, Edinburgh 1 (March 31).

BEIT FELLOWSHIPS FOR SCIENTIFIC RESEARCH—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7 (April 1).

EXPERIMENTAL OFFICERS (3, temporary) IN THE MECHANICAL ENGINEERING RESEARCH ORGANISATION of the Department of Scientific and Industrial Research:—Ref. D.48/50A, for the application of electronic techniques to the measurement of transient forces and small movements; Ref. C.89/50A, for basic research on the machinability of metals; Ref. C.90/50A, for the design and development of equipment and instruments for investigating the performance of and the flow conditions in models of pumping machinery, turbine plant, etc.—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (April 1).

ROBERT BLAIR FELLOWSHIPS IN APPLIED SCIENCE AND TECHNOLOGY—The Education Officer (H.1/2), The County Hall, Westminster Bridge, London, S.E.1 (April 1).

SCIENTIST, Grade I (with a University honours degree or equivalent qualification in chemistry, chemical engineering or fuel technology), on the staff of the Director-General to deal with administrative aspects of the Board's research work—The National Coal Board, Establishments Branch (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/196 (April 3).

LECTURER or ASSISTANT LECTURER IN MATHEMATICS at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (April 8).

SENIOR LECTURER IN VETERINARY PATHOLOGY—The Secretary and Registrar, The University, Bristol (April 8).

VETERINARY RESEARCH OFFICERS, male (one in the Senior Scientific Officer grade for a bacteriologist with experience in the study of bovine mastitis, two in the Scientific Officer grade, one in pathology and one in bacteriology)—The Director, Agricultural Research Council Field Station, Compton, Newbury, Berks (April 11).

ASSISTANT KEEPER IN EGYPTOLOGY in the Manchester Museum—The Registrar, The University, Manchester 13 (April 14).

BEIT MEMORIAL FELLOWSHIPS—The Secretary, Beit Memorial Fellowships for Medical Research, Lister Institute, Chelsea Bridge Road, London, S.W.1 (April 14).

READER IN ANTHROPOLOGY at the London School of Economics and Political Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 14).

I.C.I. RESEARCH FELLOWSHIPS IN CHEMISTRY or PHYSICS, or some allied subject such as BIOCHEMISTRY, CHEMOTHERAPY, PHARMACOLOGY, METALLURGY or ENGINEERING—The Registrar, The University, Liverpool (April 15).

LECTURER (man or woman) IN BOTANY (Plant Physiology), a LECTURER (resident, woman) IN CHEMISTRY, and an ASSISTANT LECTURER (resident, woman) IN PHYSICS—The Principal, Royal Holloway College, Englefield Green, Surrey (April 15).

LECTURER IN SOCIAL PSYCHOLOGY—The Secretary, The University, Aberdeen (April 15).

SHELL RESEARCH STUDENTSHIP for research in CHEMICAL ENGINEERING—The Shell Professor of Chemical Engineering, Department of Chemical Engineering, Tennis Court Road, Cambridge (April 18).

PROFESSOR OF AGRICULTURE at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (April 29).

HARRY BOLUS CHAIR OF BOTANY, and a SENIOR LECTURER IN GEOLOGY, in the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (April 30).

INTERNATIONAL WOOL SECRETARIAT RESEARCH SCHOLARSHIPS—The Registrar, The University, Manchester 13 (April 30).

LECTURER IN MATHEMATICS (with special reference to the field of statistics) at the University of Malaya—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (April 30).

RESEARCH FELLOW (qualified to undertake theoretical work relating to electromagnetic waves in low pressure electrical discharges and to solar and cosmic noise) in the School of Physics—The Registrar, University of Sydney, Sydney, N.S.W., Australia (April 30).

COATS FELLOWSHIP for research in CHEMISTRY or PHYSICS (excluding nuclear physics)—The Clerk of Senate, The University, Glasgow, W.2 (May 31).

ASSISTANT WORKS MANAGER (with an honours degree in chemistry or Associateship of the R.I.C. or equivalent qualifications) in the Ministry of Supply Division of Atomic Energy (Production), Springfields Factory, Salwick, near Preston, to be responsible to the Works Manager for the operation of the plant in a large chemical factory—The Administration Branch, Division of Atomic Energy (Production), Risley, near Warrington, Lancs.

MECHANICAL or ELECTRICAL ENGINEERS as Inspectors of Machinery in the Mines Department, Gold Coast Colony—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27099/21.

PHYSIOLOGICAL CHEMIST to undertake work particularly in the field of ruminant digestion—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Standard 1427 : 1949, Tests for Water used in Steam Generation, Group A, Control Tests for which no Laboratory is Required. Pp. 80. 7*s.* 6*d.* net. Addendum No. 1 : 1949 to British Standard 350 : 1944, Conversion Factors and Tables. Pp. 27. 2*s.* net. (London : British Standards Institution, 1949.) [1212

Department of Scientific and Industrial Research : Forest Products Research. Bulletin No. 23 : Flooring Softwoods, their Wear and Anatomical Structure. By F. H. Armstrong. Pp. 4+7 plates. (London : H.M. Stationery Office, 1949.) 9*d.* net. [1312

Science in Industry. Bulletin No. 4 (New Series) : Technical Knowledge as an Exportable Commodity. Pp. 22. (London : Murray, Bull and Co., Ltd., 1949.) [1312

Ministry of Agriculture and Fisheries. Technical Bulletin No. 2 : Laboratory Methods for Work with Plant and Soil Nematodes. By Dr. T. Goodey. Pp. 20+4 plates. (London : H.M. Stationery Office, 1949.) 9*d.* net. [1312

History of the Berwickshire Naturalists' Club. Vol. 31, Part 2. Pp. iv+65–179+plates 8–13. (Lauder : H. H. Cowan, Secretary, The Roan, 1949.) 10*s.* ; to Members, 7*s.* 6*d.* [1412

Wellcome Historical Medical Museum. Catalogue of an Exhibition of Books, Manuscripts and Relics commemorating the Bicentenary of Edward Jenner, 17 May 1749–26 Jan. 1823. (Published for the Trustees, the Wellcome Historical Museum.) Pp. 36+2 plates. (London : Oxford University Press, 1949.) 2*s.* net. [1412

British Flowering Plants and Modern Systematic Methods. Being the Report of the Conference on the Study of Critical British Groups arranged in April 1948 by the Botanical Society of the British Isles. Edited by A. J. Wilmott. Pp. 102. (London : Botanical Society of the British Isles, c/o British Museum (Natural History), 1949.) 10*s.* [1412

Department of Scientific and Industrial Research. Report of the Geological Survey Board for the Year 1948. Pp. ii+18. (London : H.M. Stationery Office, 1949.) 6*d.* net. [1512

Other Countries

Sitzungsberichte der Deutschen Akademie der Wissenschaften zu Berlin, Mathematisch-naturwissenschaftliche Klasse. Jahrgang 1948, Nr. 7 : Die Ableitung der Eigenbewegungen von Sternen der AG-Kataloge mit Benutzung der Photographischen Himmelskarte, insbesondere in der Zone +20° bis 25° (Berlin B). Von O. Heckmann, W. Dieckvoss und H. Kox. Pp. 32. 2.65 D. marks. Jahrgang 1949, Nr. 1 : Ein neuer Erhaltungs-Satz der Hydrodynamik. Von Hans Ertel und Carl-Gustav Rossby. Pp. 11. 1.50 D. marks. (Berlin : Akademie-Verlag, 1949.) [1312

Parliament of the Commonwealth of Australia. Twenty-second Annual Report of the Council for Scientific and Industrial Research for the Year ended 30th June 1948. Pp. 141. (Canberra : Commonwealth Government Printer, 1949.) 8*s.* [1312

Bureau des Longitudes. Annuaire pour l'an 1950. Pp. viii+604+A15+B86+C61. (Paris : Libr. Gauthier-Villars, 1950.) [1312

New Zealand : State Forest Service. Annual Report of the Director of Forestry for the Year ended 31st March 1949. Pp. 86. (Wellington : Government Printer, 1949.) 1*s.* 9*d.* [1412

Academie Royale de Belgique, Classe des Sciences. Mémoires, Tome 31, Fasc. 4 : Introduction à l'electrodynamique des conducteurs en mouvement. Par Prof. Jean Bosquet. Pp. 85. (Bruxelles : Academie Royale de Belgique, 1948.) 60 francs. [1412

Illinois Natural History Survey. Bulletin, Vol. 25, Article 2 : Effect of Permanent Flooding in a River-Bottom Timber Area. By Lee E. Yeager. Pp. 29–66. (Urbana : Illinois Natural History Survey, 1949.) [1512

University of California Publications in Zoology. Vol. 48, No. 6 : Speciation in Salamanders of the Plethodontid Genus *Ensatina*. By Robert C. Stebbins. Pp. v+377–526 (plates 11–16). (Berkeley and Los Angeles : University of California Press ; London : Cambridge University Press, 1949.) 2.50 dollars. [1512